

APPENDIX 7. PEER REVIEWER COMMENTS

Peer Reviewers:

Lowell V. Diller, Ph.D.

Katie M. Dugger

Alan B. Franklin, Ph.D.

Elizabeth M. Glenn, Ph.D.

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Comments from Lowell V. Diller, Ph.D.

From: [Lowell Diller](#)
To: [Clipperton, Neil@Wildlife](mailto:Clipperton_Neil@Wildlife)
Cc: [Battistone, Carie@Wildlife](mailto:Battistone_Carie@Wildlife)
Subject: RE: Northern Spotted Owl Status Review - External Peer Review
Date: Friday, October 09, 2015 12:15:21 PM
Attachments: [image001.jpg](#)
[CA NSO status review \(L.Diller comments 10-1-15\).pdf](#)
[NSO SR external peer review 8Sept2015 \(L. Diller\).docx](#)

Hi Neil,

Thanks for the opportunity to review the status report. If you did most of the work, I commend you on taking on such a daunting task and doing a great job. I made quite a few comments, which is not a reflection on you and whoever else worked on this but the massive amount of information and complexity of the issues. Good job and good luck trying to incorporate all the divergent comments you are likely to receive.

I am going to send all the attachments in several emails. The first is my general comments and the draft status review with my comments.

Lowell

From: Clipperton, Neil@Wildlife [mailto:Neil.Clipperton@wildlife.ca.gov]
Sent: Tuesday, October 06, 2015 10:58 AM
To: Lowell Diller <ldillerconsulting@gmail.com>
Cc: Battistone, Carie@Wildlife <Carie.Battistone@wildlife.ca.gov>
Subject: RE: Northern Spotted Owl Status Review - External Peer Review

Hi Lowell,

Tomorrow or the next day will be okay. We appreciate the effort.

Neil

From: Lowell Diller [<mailto:ldillerconsulting@gmail.com>]
Sent: Tuesday, October 06, 2015 10:26 AM
To: Clipperton, Neil@Wildlife
Cc: Battistone, Carie@Wildlife
Subject: RE: Northern Spotted Owl Status Review - External Peer Review

Hi Neil,

I am getting close, but I won't be able to complete my review today. I hope to be able to get it to you tomorrow or Thursday. I hope that doesn't cause any problems for you.

Lowell

From: Clipperton, Neil@Wildlife [mailto:Neil.Clipperton@wildlife.ca.gov]

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
NORTHERN SPOTTED OWL
(*Strix occidentalis caurina*) IN CALIFORNIA



CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
EXTERNAL REVIEW DRAFT, September 8, 2015



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Comment [A1]: 1. Note to external reviewers:
These appendices will be added later.

Acknowledgments (to be completed after external review)

This report was prepared by: Neil Clipperton and Carie Battistone

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**Report to the Fish and Game Commission
A Status Review of the Northern Spotted Owl in California
EXTERNAL REVIEW DRAFT, September 8, 2015**

Executive Summary

[TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]

Regulatory Framework

Petition Evaluation Process

A petition to list the Northern Spotted Owl as threatened or endangered under the California Endangered Species Act (CESA) was submitted to the Fish and Game Commission (Commission) on September 7, 2012 by the Environmental Protection Information Center. A petition evaluation report was prepared by the Department of Fish and Wildlife (Department) and submitted on February 14, 2013, to assist the Commission in making a determination as to whether the petitioned action may be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & (e)).

The Department's charge and focus in its advisory capacity to the Commission is scientific. A petition to list or delist a species under CESA must include "information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The Petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and other factors the Petitioner deems relevant" (Fish & G. Code, § 2072.3). Given this charge the Department recommended to the Commission that the petition be accepted.

Status Review Overview

The Commission published findings of its decision to advance the species to candidacy on December 27, 2013, triggering a 12-month period during which the Department conducted a status review to inform the Commission's decision on whether to list the species. Per Fish & G. Code, section 2074.6, the Department requested a 6-month extension, to allow further analysis and evaluation of the available science, completion of the status review, and peer review process. Due to the extension, Department had a total of 18 months from December 27, 2013 to deliver the status review to the Commission.

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This written status review report indicates, based upon the best scientific information available, whether the petitioned action is warranted, preliminary identifies habitat that may be essential to the continued existence of the species, and recommends management activities and other recommendations for recovery of the species (Fish & G. Code, § 2074.6). Receipt of this report is to be placed on the agenda for the next available meeting of the Commission after delivery. At that time, the report will be made available to the public for a 30-day public comment period prior to the Commission taking any action on the Department’s recommendation.

Existing Regulatory Status

Endangered Species Act

The U.S. Fish and Wildlife Service listed the Northern Spotted Owl as threatened under the Endangered Species Act in 1990. Critical habitat designation occurred in 1992 and was revised in 2008, and a new final rule designating critical habitat was published in December 2012. The first final recovery plan for the Spotted Owl was issued in 2008 and revised in 2011.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act prohibits anyone from taking, killing, or keeping any native bird, its parts, or its nest, without a permit or license. All raptors native to the U.S. are covered by this law. A Special Purpose Possession Permit and/or Endangered Species Permit (depending on species), is required under the Migratory Bird Treaty Act to keep raptors.

California Endangered Species Act

After the Commission voted to accept the petition in December, 2013, the Northern Spotted Owl became a State candidate for threatened or endangered status under the California Endangered Species Act, commencing with section 2050 of the California Fish and Game Code

California Bird Species of Special Concern

The Department currently designates the Northern Spotted Owl as a Species of Special Concern.

Fish and Game Code

The Fish and Game Code includes certain protections for raptors, including the Northern Spotted Owl. Sections applicable to owls include the following:

Section 3503 - It is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.

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298 Section 3503.5 - It is unlawful to take, possess, or destroy any birds in the orders Falconiformes
299 or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird
300 except as otherwise provided by this code or any regulation adopted pursuant thereto.

301 Section 3513 - It is unlawful to take or possess any migratory nongame bird as designated in the
302 Migratory Bird Treaty Act or any part of such migratory nongame bird except as provided by
303 rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory
304 Treaty Act.

305 *California Board of Forestry and Fire Protection*

306 The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire
307 Protection (CAL FIRE) have designated Northern Spotted Owl as a "Sensitive Species" as identified in the
308 California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules).
309 These sections also define Northern Spotted Owl -related terminology, including "activity center",
310 "Northern Spotted Owl breeding season", and "Northern Spotted Owl Evaluation Area." Specific
311 requirements for the disclosure of information on Northern Spotted Owls in the context of timber
312 harvesting, which in all but one case avoid take of Northern Spotted Owl are provided by Forest Practice
313 Rules sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted
314 Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by
315 CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and
316 related activities, would be avoided according to the criteria for determining take avoidance found in
317 Section 919.10. Other language within Section 919 also compels methods to avoid take of Northern
318 Spotted Owl. Sections 919.2 and 919.3 set up protections of bird nests through buffers and avoidance of
319 sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the
320 protections afforded to late successional forests, which are a component of Northern Spotted Owl
321 habitat.

322 *International Union for Conservation of Nature*

323 The International Union for Conservation of Nature Red List of Threatened Species status for the
324 Spotted Owl range-wide is "Near Threatened" because the "species has a moderately small population
325 which continues to decline in northern and western parts of its range."

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Biology and Ecology of the Northern Spotted Owl

Life History

Species Description

The Northern Spotted Owl is a medium-sized dark brown owl, with a barred tail, white spots on its head and breast, and dark brown eyes surrounded by prominent facial disks (Forsman et al. 1993, Gutiérrez et al. 1995). Overall, its length is approximately 46 to 48 centimeters (18 to 19 inches) (Forsman et al. 1993). Males and females are dimorphic in size, with males averaging about 13 percent smaller than females (USFWS 2011a). Males weigh between 430 to 690 grams (0.95 pound to 1.52 pounds), and females weigh between 490 to 885 grams (1.1 pounds to 1.95 pounds) (P. Loschl and E. Forsman pers. comm. 2006 in USFWS 2011a). The Northern Spotted Owl resembles the Barred Owl (*Strix varia*) in appearance, and first generation hybrids of the two species exhibit physical and vocal characteristics of both (Hamer et al. 1994, Kelly and Forsman 2004).

Comment [LVD2]: 2.I think it would be useful to add the pattern of dark spots on its breast, bill color (yellowish-green) and a description of their talons (tannish and long for their size). The pattern of spots, bill and talon color are things that can be used to distinguish spotted from barred owls.

Comment [LVD3]: 3. There is no USFWS 2011b cited so there is no reason for a 2011a.

Comment [LVD4]: 4. This doesn't seem like it contributes much to the species description since the appearance of the barred owl has not been described. It also seems awkward that characteristics of the hybrids are described before there has been any mention of the hybridization potential between the two species. I recommend adding a paragraph at the start of the barred owl threat section that describes the physical differences between spotted and barred owls.

Taxonomy and Genetics

The American Ornithologists' Union recognizes the Northern Spotted Owl as one of three subspecies of Spotted Owls. The two other subspecies are the California Spotted Owl (*S. o. occidentalis*), ranging in the southern Cascade Range of northern California south along the west slope of the Sierra Nevada and in mountains of central and southern California, and Mexican Spotted Owl (*S. o. lucida*) ranging from southern Utah and Colorado south to Michoacán, Mexico. The taxonomic separation of these three subspecies is supported by genetic, morphological, and biogeographic information (Barrowclough and Gutiérrez 1990, Gutiérrez et al. 1995, Haig et al. 2004a, Chi et al. 2005, Henke et al. 2005, Barrowclough et al. 2005, Funk et al. 2008, AOU 2011, Barrowclough et al. 2011). The Marin County population of Northern Spotted Owl is genetically isolated from other Spotted Owl populations in California (Jenson et al. 2006).

There is a narrow, apparently stable zone where hybridization occurs between the Northern and California Spotted Owl in the Southern Cascades and Northern Sierra Nevada Mountains near the Pit River in California (Courtney et al. 2004, Barrowclough et al. 2005). There is evidence in all genetic studies conducted on the species of some genetic mixing of California Spotted Owl into the Northern Spotted Owl range, and fewer examples of the opposite (Courtney et al. 2004). In the Klamath region of California 20.3% of owls were classified as California Spotted Owls (Haig et al. 2004a). Among all Northern Spotted Owls sampled across their range in Oregon, Washington, and California, 12.9% contained California Spotted Owl haplotypes (Haig et al. 2004a). There has been some evidence for genetic flow between Mexican Spotted Owls and Northern Spotted Owls, primarily in Washington, indicating long-distance dispersal of Mexican Spotted Owls most likely via the Rocky Mountain dispersal route (Funk et al. 2008). Until recently, there has been little evidence in the literature of loss of genetic variation and population bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across the range of the Northern Spotted Owl (Washington Cascade Mountains,

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Oregon Cascade Mountains, Oregon Coast Ranges, and Klamath Mountains of Oregon and California) provides compelling evidence that a population bottleneck may have occurred, with more prominent bottlenecks in the Washington Cascade Mountains as compared to other regions in the analysis (Funk et al. 2010).

Since the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two species have resulted as well. The majority of hybrids that have been evaluated with genetic methods have resulted from a cross between a female Barred Owl and a male Spotted Owl (Haig et al 2004b, Kelly and Forsman 2004). First generation hybrids share phenotypic and vocal characteristics of both parent species (Hamer et al. 1994). Second generation hybrids are often difficult to distinguish from Barred or Spotted Owls in the field and genetic testing may be the only sure method of identification (Kelly and Forsman 2004). Both first and second generation hybrids were found to be reproductively viable in some cases (Kelly and Forsman 2004). Zach Hanna data?

Comment [LVD5]: 5. There are also lots of field observations to support the female barred with male spotted cross.

Comment [LVD6]: 6. It seems to me the relevance of hybridization for NSO genetics is the potential for introgression from barred to spotted owls. Zach Hanna, Ph.D. student at Berkeley is looking at spotted/barred owl genetics with emphasis of potential introgression. It would be worth checking to see if he has any data that are available.

Geographic Range and Distribution

The current range of the Northern Spotted Owl extends from southwest British Columbia through the Cascade Range, coastal ranges, and intervening forested lands in Washington, Oregon, and northern California, as far south as Marin County (USFWS 1990). The transition between subalpine to alpine forests marks the upper elevation limit at which Northern Spotted Owls are known to occur (Forsman 1975, Forsman et al. 1984). Prior to the mid-1800s, Northern Spotted Owls are believed to have inhabited most old-growth forests or stands throughout the Pacific Northwest, including northwestern California (USFWS 2011a). Although the overall range is not known to have changed, the Spotted Owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon (USFWS 2011a). Local declines have been observed in many portions of the range (see Status and Trends and Barred Owl sections of this report).

The range has been partitioned into 12 physiographic provinces based on landscape subdivisions with different environmental features (Thomas et al. 1990) (Figure 1). This total range of the Northern Spotted Owl has been estimated to have an extent of 230,690 km² (57 million acres) (USDA and USDI 1994).

The 12 physiographic provinces are distributed across the species' range as follows:

- Four provinces in Washington: Eastern Washington Cascades, Olympic Peninsula, Western Washington Cascades, Western Washington Lowlands
- Five provinces in Oregon: Oregon Coast Range, Willamette Valley, Western Oregon Cascades, Eastern Oregon Cascades, Oregon Klamath
- Three provinces in California: California Coast, California Klamath, California Cascades

In California, the Northern Spotted Owl range runs south as far as Marin County in the Coast Ranges and across the Klamath Mountains of northern California east to the Cascade Range where it meets the range of the California Spotted Owl (*S. o. occidentalis*) near the Pit River (Figure 2). The California Coast

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Province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of national forest lands. The California Klamath Province is between the California Coast Province to the west and the California Cascades province to the east, and is a continuation of the Oregon Klamath province, with a southern boundary at the Clear Lake Basin in the inner Coast Range. The California Cascades province is bounded on the west by the Sacramento Valley and the Klamath Mountains, on the east by the Modoc Plateau and Great Basin, and to the south by the Sierra Nevada Mountains (USFWS 1992, Courtney et al. 2008).

Broad-scale patterns of relative abundance of Spotted Owls are suggested by the distribution of recorded Northern Spotted Owl activity centers across the landscape. An activity center is a known Northern Spotted Owl site documented from survey detections (See Appendix 2 for a more detailed definition of activity center). Lower interior ~~numbers~~ ~~densities~~ of Northern Spotted Owl are acknowledged in the 2011 Recovery Plan (USFWS 2011a), which states, "...the dry forest portion of the Spotted Owl's range hosts a minority of the overall population..." Records from the Department's Spotted Owl Database indicate that generally ~~fewer~~ activity centers occur ~~at lower densities~~ in the drier portions of the interior Klamath and Cascade ranges, compared to the Coastal Range and wetter portions of the Klamath Province (Figure 3). It appears many activity centers within the Coast Province have been documented only beginning in the 1990s. This is ~~likely due largely~~ to increased survey effort by private timber companies following the listing by the federal government rather than an increase in Spotted Owl territories in the Coast Province, although Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property in Humboldt and Del Norte counties that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature (GDRC 2015). Humboldt Redwood Company has also reported an increase in number of sites since 2008, but acknowledges the possibility that the increase may be due to the displacement of Spotted Owls to new sites as a result of increasing numbers of Barred Owls (HRC 2015). Large timber companies in the coastal portion of the range have identified a large number of activity centers on their ownerships, with more than 200 activity centers on some ownerships. Consistent with the general pattern, private ownerships in the interior ~~have lower densities of~~ ~~report fewer~~ Northern Spotted Owls activity centers, but some timber companies still ~~host-report~~ close to a hundred activity centers (Calforests 2014). Caution must be used when examining these data; activity center sites ~~do may~~ not represent the actual number or density of owls across the range in California due to the nature of how the data are collected and reported. Data are often collected inconsistently based on local project-level monitoring needs and not all data ~~is-are~~ reported to the Department's database. Also, activity centers are generally retained in the database over time regardless of annual occupancy status (see Status and Trends section of this report).

Reproduction and Development

The Northern Spotted Owl is relatively long-lived with a long reproductive life span (Forsman et al. 1984, Gutiérrez et al. 1995), with wild owls living up to 20 years. Owls are reproductively mature at 1 year of age, but generally do not reproduce for the first time until 2 to 5 years of age (Reference? You could use Forsman et al. 2011, but I would change the age for first reproduction to generally 2-3 years). Courtship

Comment [LVD7]: 7. Wouldn't all of this discussion fit better in the "Density" section below?

Comment [LVD8]: 8.1 would be careful using the term "density" unless surveys have been conducted that delineate number of owl sites per unit area surveyed.

Comment [LVD9]: 9.1 think you can be much more emphatic since no surveys were conducted on private timberlands until 1989.

Comment [LVD10]: 10. However, this doesn't represent a net increase, because other sites are being lost while some sites are being gained. What it represents is the dynamic nature of habitat on managed timberlands where the pattern of timber harvest creates good habitat in some areas while eliminating habitat in other areas.

Comment [LVD11]: 11. This last paragraph is all about abundance and population trends, but it is in the section entitled "Geographic Range and Distribution." I would move this last paragraph to the "Density" and "Status and Trends" sections.

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initiates in February or March, with the first eggs laid in late March through April (Miller et al. 1985, Franklin 1992, Forsman et al. 2002). Timing of breeding onset varies by latitude and elevation, with delayed nesting occurring at higher elevations and latitude (Forsman et al. 1993). Females typically lay 1 to 4-2 eggs per clutch, with but rarely 23 eggs and even 4 eggs per clutch most common have been documented (Forsman et al. 1984, USFWS 1990, Anthony et al. 2006). Incubation, performed exclusively by the female, lasts about 30 days (Courtney et al. 2004). Brooding is almost constant for the first 8 to 10 days and is also done exclusively by the female, after which the female will take short trips off of the nest to hunt (Courtney et al. 2004). The male provides all the food to the nest during incubation and the first 10 days of brooding (Courtney et al. 2004). Chicks fledge from the nest in late May or in June and continue to be dependent on their parents into September until they are able to fly and hunt for food on their own (Forsman et al. 1984, USFWS 1990). Adults can typically be found roosting with young during the day for the first few weeks after they leave the nest, after which adults typically begin roosting further from the young throughout the summer months and only visit their young during the night to deliver food (Forsman et al. 1984). By November, most juveniles begin to disperse (Miller et al. 1997, Forsman et al. 2002, Courtney et al. 2004).

Most Spotted Owls do not breed every year, but more normally breed every other year (Forsman et al. 2011). The reason for this biennial breeding pattern is unknown, but may be due to the large time investment and energy cost to produce young (Forsman et al. 2011). Annual variation in reproductive success is thought to be related to weather conditions and fluctuations in prey abundance, but may also be related to individual variation, age, and habitat quality within the territory (Forsman et al. 1993, Forsman et al. 2011). Small clutch size, temporal variation in nesting and nest success, and long onset of breeding maturity all contribute to low fecundity for the Northern Spotted Owl (Gutiérrez 1996).

Population Density

Population density (i.e., number of individuals per unit of area) estimates for Northern Spotted Owl are difficult to obtain due to the level of effort required to survey all potential habitat in a given area. Furthermore, population densities can only be determined for territorial individuals since the “floater” or non-territorial owls do not respond to surveys utilizing broadcast lure calls. Density has been estimated for specific study areas, but not across the species’ entire range; several estimates of density are available from sites in California (Table 1). Franklin et al. (1990) estimated crude density (territorial owls/km²) of owls in the Willow Creek Study Area, Humboldt County, at 0.235 owls/km² (95% CI = 0.214-0.256), and ecological density (number of individuals/ km² of habitat) at 0.544 owls/km² (95% CI = 0.495-0.592) and 0.660 owls/km² (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km². Diller and Thome (1999) estimated crude density for owls in their northern California coast study area in Humboldt, Trinity and Del Norte counties to be 0.092 owls/km²±0.006, 0.351 owls/km²±0.011, and 0.313 owls/km²±0.017 for Klamath, Korbelt and Mad River regions respectively, with an overall mean density of 0.209 owls/km²±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbelt, and Mad River respectively (Diller and Thome 1999). The 2015 annual report for Green Diamond Resource Company Northern Spotted Owls Habitat Conservation Plan (GDRC 2015) notes a reported an empirical

Comment [LVD12]: 12. On the coast, there aren't the big boom and bust years. We have documented close to a 1,000 nesting attempts on Green Diamonds study area and have only seen a clutch of 3 a couple of times. In the more inland areas, more extreme drought and wet cycles produce more extremes in clutches with triplets quite common in really good years and even the occasional clutch of 4. However, the mean clutch size in every study area is < 2.0 meaning that clutches of 3 or 4 are very rare.

Comment [LVD13]: 13. Already stated in the previous sentence.

Comment [LVD14]: 14. It is our experience that throughout incubation, females will come off the nest for 10-15 minutes to eat prey brought in by the male, defecate and preen. But the female relies completely on the male to be fed during incubation. I know Courtney et al. (2004) reported that the females forage on their own later in incubation based on Eric Forsman's work, but I wonder if that is an Oregon phenomenon where the primary prey is flying squirrels, which occur in much lower densities requiring females to do some foraging on their own. In our study area, woodrats are the primary prey and it seems like the females always have a cached woodrat nearby that the male has delivered. BTW, ... [1]

Comment [LVD15]: 15. This contradicts the previous statement where the female starts making short foraging trips during incubation. None of this is critical information for the status review, but I would recommend combining these two sentences to say something like: “During incubation and the early part of brooding, ... [2]

Comment [LVD16]: 16. I think it would be worth noting the owlets typically “fledge”, which implies they are capable of flight, at a very premature stage when they are not truly flighted, but have to “limb hop” to move through the forest. At this stage, we have seen them fall and end up on or near the ground. In these cases ... [3]

Comment [LVD17]: 17. That seems really late to be dispersing. Courtney et al. 2004 says that some juveniles begin to disperse in September and most have dispersed by early November. Our experience is that almost all of our fledglings disappear by September, although we didn't put radios on them to determine ... [4]

Comment [LVD18]: 18. Turnover at a site (i.e., one member of the pair is replaced by a new owl) has also been shown to negatively influence reproductive success (Thome et al. 2000 – Thome, Darrin M., Cynthia J. Zabel and Lowell V. Diller. 2000. Spotted owl turnover and reproduction in managed forest of north- ... [5]

Comment [LVD19]: 19. This may seem like a picky point, but “density” is a physical term that refers to the mass per unit volume. Of course, everyone knows what you mean by “density” so I recommend just using “population density” in the header and definition.

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density estimate (i.e., naïve count without accounting for detection probabilities) of 0.17 owls/km² in the northern portion of their land in Humboldt County, and 0.78 owls/km² in southern portions. Sierra Pacific Industry reported 0.450 owls/km² between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km² between 2011 and 2013 on their lands in Trinity, Siskiyou, Shasta, Modoc and Lassen counties (Roberts et al. 2015). In Mendocino County, Mendocino Redwood Company reported a density of 1.89 occupied territories/km² of area surveyed (MRC 2014). Lastly, Humboldt Redwood Company (HRC) reported 1.22 occupied territories/km² and 2.23 owls/km² of area surveyed on their lands in Humboldt County (HRC 2013).

Table 1. Population density estimates for Northern Spotted Owls within various study areas throughout the range in California. I suggest adding footnotes for all the studies that are statistically rigorous estimates with 95% CI's based on banded birds versus those that are empirical counts with and without banded owls.

Source	Density Measure	Location
Franklin et al. 1990	0.235 territorial owls/km ² 0.544 number of owls/ km ² of habitat 0.660 number of owls/ km ² of habitat	Willow Creek Study Area in Humboldt County
Tanner and Gutiérrez1995	0.219 owls/km ²	Redwood National Park in Humboldt County
Diller and Thome 1999	0.092 owls/km ² (Klamath) 0.351 owls/km ² (Korbel) 0.313 owls/km ² (Mad River) 0.209 owls/km ² (mean)	Northern California coast study area in Humboldt, Trinity and Del Norte counties
GDRC 2015	0.170 owls/km ² (northern) 0.780 owls/ km ² (southern)	Green Diamond Resource Company land in Humboldt County
Roberts et al. 2015	0.450 owls/km ² between 1989 and 2003 0.450 owls/km ² between 2003 and 2007 0.459 owls/km ² between 2011 and 2013	Sierra Pacific Industry lands in Trinity, Siskiyou, Shasta, Modoc and Lassen* counties
MRC 2014	1.89 occupied territories/km ² of area surveyed	Mendocino Redwood Company in Mendocino County
HRC 2013	1.22 occupied territories/km ² of area surveyed 2.23 owls/km ² of area surveyed	Humboldt Redwood Company in Humboldt County

* Densities were reported for Modoc and Lassen counties in this study; however these counties are not within the range of the Northern Spotted Owl. Sierra Pacific Industry lands in this study overlap with the Northern Spotted Owl and California Spotted Owl ranges.

As apparent from the reports of density estimates above, there is considerable variation among studies even though most studies occurred within the coastal forests. This variation in density may be attributed to habitat availability, habitat heterogeneity, territoriality, weather patterns, and presence of Barred Owls (Franklin et al. 1990, Diller and Thome 1999, Courtney et al. 2004 Sovern et al. 2014). Another possible explanation of the variation is that data collection and analysis varied among the studies. Given this, it is nearly impossible to extrapolate density across the entire California range for Northern Spotted Owl.

Comment [LVD20]: 20.I assume all of these other estimates are empirical counts because none of them report a 95% CI. I suspect that most of these are also not based on banded owls. I would suggest adding a note of caution when interpreting these estimates of population density because empirical counts can be under estimates since they don't account for birds not detected. However, if many of the birds are not banded, the empirical counts can also result in "double counting" birds that move throughout the season and produce over estimates.

Comment [LVD21]: 21. There really isn't that much variation among the statistically rigorous estimates.

Comment [LVD22]: 22. It would be appropriate to again add a caution about interpreting results of empirical counts particularly of unbanded owls.

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498 *Hunting and Food Habits*

499 As described in Forsman et al. (1993), Northern Spotted Owls are sit and wait (e.g., perch and pounce)
500 predators. They mostly hunt during nighttime hours (i.e., nocturnal), but will forage during the day as
501 well (Forsman et al. 1984, Sovern et al. 1994, Forsman et al. 2001). Generally, flying squirrels
502 (*Glaucomys sabrinus*) are the main component of the diet in Douglas-fir and western hemlock forest
503 within the northern portion of the owl's range (in Washington and Oregon); whereas in the southern
504 portion of the range (Oregon Klamath, California Klamath, and California Coastal Provinces) dusky-
505 footed woodrats (*Neotoma fuscipes*) are the main component of the diet (Forsman et al. 1984, 2001,
506 2004, Zabel et al. 1995, Ward et al. 1998, Franklin et al. 2000, Hamer et al. 2001, Dugger et al. 2005). A
507 study in Humboldt and Del Norte counties of coastal California indicated that dusky-footed woodrats
508 comprised 45% of the frequency and 74% of the prey biomass, but tree voles and flying squirrels were
509 also important in the overall composition of the owl's diet (Diller et al. 2010). Other prey items seen in
510 the owl's diet in smaller proportions include deer mice, tree voles, red-backed voles, gophers, snowshoe
511 hare, bushy-tailed woodrats, small to medium sized birds, bats, and insects (Forsman et al. 1984, 2001,
512 2004, Ward et al. 1998, Hamer et al. 2001). A study within the Southern Cascades and Klamath
513 Provinces in California (Timber Products Company timberland) identified 16 species of mammals, 5
514 species of birds, and 1 species of insect among 224 pellets collected, with major prey items being 58.3%
515 woodrat sp., 29.2% Northern flying squirrel, 3.9 % broadfooted mole, 3.9% rabbit and 1.4% gopher
516 (Farber and Whitaker 2005).

517 Diet analysis conducted in Washington during the fall and winter months indicated seasonal variation in
518 prey species consumed as a function of the availability of the owl's preferred prey species during various
519 portions of the year (Forsman et al. 2001). In the Washington study area, flying squirrels were more
520 prevalent in the diet during fall and winter months, whereas prey species that hibernated or spent the
521 winter under the snow (e.g., chipmunks and pikas) were missing from the diet during the same period.
522 During the spring, summer and early fall months consumption of insects, gophers, and snowshoe hares
523 occurred more frequently (Forsman et al. 2001). Forsman et al. (2001) noted that diets varied among
524 territories even within the same forest type with much of the variation attributed to differences in
525 spatial abundance of prey, but other factors, such as individual preferences, experience, prey
526 accessibility, or timing of pellet collection, may have played a role. While the populations in California
527 are geographically distinct, and hunting and food habits may differ somewhat from owls in Washington,
528 Northern Spotted Owls in California likely vary diet seasonally according to the spatial distribution and
529 abundance of their preferred prey.

530 Metabolic measurements made on California Spotted Owls in Weathers et al. (2001) showed very low
531 basal metabolic rates compared to other owl species, thereby leading to very low energy requirements.
532 Field metabolic rate on adults actively caring for young averaged only 34% of the metabolic rate
533 predicted for other avian species of the same size (Weathers et al. 2001). Considering this low metabolic
534 rate, Weathers et al. (2001) found that, on average, owls can meet their energy requirements by
535 consuming one northern flying squirrel every 1.8 days or one woodrat every 3.7 days. Given the known

Comment [LVD23]: 23. Most scientific papers list the species scientific name the first time it is used.

Comment [LVD24]: 24. Diller, L., K. Hamm, D. Lamphear and T. McDonald. 2010. Green Diamond Resource Company, Northern Spotted Owl Habitat Conservation Plan, Ten-Year Review Report. Report to U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, California. 232 + viii pp.

Comment [LVD25]: 25. Are you sure this is "preference" or simply "availability?" The following sentences suggest it is mostly availability.

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536 | [genetic exchange between these two subspecies](#), ~~Th~~^{is} low metabolic requirement is likely similar to
537 | that of Northern Spotted Owls, though no known study has been conducted on this subspecies.

538 | There is strong evidence that prey abundance and availability affect selection and use of habitat and
539 | home range size of Northern Spotted Owls across their range (Zabel et al. 1995). In northwest California,
540 | Northern Spotted Owls were found to forage in areas where the occurrence of prey was more
541 | predictable, within older forests, and near ecotones of old forest and brush seral stages (Ward 1990 as
542 | cited in USFWS 2011a). Owls tend to select old-growth forests with less edge habitat and have larger
543 | home ranges when flying squirrels are the dominant prey, whereas they tend to select variable-aged
544 | stands with more edge habitat when woodrats are the dominant prey (Courtney et al. 2004). In these
545 | variable-aged stands, older forests remain an important component of nesting and roosting habitat.
546 | Where woodrats are the dominant prey, the amount of edge between older forests and other habitat
547 | types in Oregon was found to have a positive effect on foraging success and subsequent reproductive
548 | success due to increased prey availability (Olson et al. 2004). Where woodrats are the primary prey
549 | item, young seral stages often provide high quality prey habitat but provide limited foraging
550 | opportunities for Spotted Owls due to a lack of perches from which to hunt or to prey inaccessibility in
551 | the dense undergrowth; however, when young seral forests are adjacent to older forest stands surplus
552 | woodrats may disperse into these older forests making them more vulnerable to predation by Spotted
553 | Owls (Meyer et al. 1998, Franklin et al. 2000, Zabel et al. 2003, Olson et al. 2004). In the northwestern
554 | California coast redwood zone and the mixed conifer forests in the interior of the California range near
555 | Yreka, California, studies have shown that Spotted Owls will forage in recent harvest-created hardwood
556 | and shrub habitat (i.e., within 6-30 year old clearcuts) that contain woody debris, scattered conifers and
557 | snags, and that are adjacent to older forests (Irwin et al. 2013). [Similar results have also been reported](#)
558 | [for a study in the coastal redwood region \(Diller et al. 2010\)](#). Winter use of these areas was more
559 | pronounced in areas with 9-18 m²/ha basal area (Irwin et al. 2013).

560 | *Home Range and Territoriality*

561 | Northern Spotted Owls are [highly](#) territorial. Territories, [a core area of the entire home range including](#)
562 | [the nest and primary roosting areas](#), are actively defended using aggressive vocal displays, and even
563 | physical confrontations on the rare occasion (Courtney et al. 2004, [Van Lanen et al. 2011](#)). Because of
564 | their [high-strong](#) territoriality, broadcast surveys are generally a very effective method for determining
565 | presence of [resident](#) Spotted Owls (Courtney et al. 2004); however, calling may be suppressed by the
566 | presence of Barred Owls (see Barred Owl section of this report). ~~Territory size~~ [Home range, the total](#)
567 | [area utilized by an individual owl for all its life needs, varies](#) for Northern Spotted Owls ~~varies~~
568 | on the setting and structure of the habitat (e.g., canopy closure, understory composition, and slope),
569 | number of available nesting and roosting sites, and location relative to suitable foraging habitat
570 | (Courtney et al. 2004). In general, Spotted Owls have a broad home range with a centrally located nest
571 | and roosting site. For this reason, Spotted Owls are considered central place foragers during the
572 | breeding season when they are tied to a central nesting or roosting site. [Spotted Owls often occupy a](#)
573 | [home range that is larger than the core use area, and may use an area that is larger than the portion of](#)
574 | [the home range which is defended \(i.e., home ranges may overlap with that of other Spotted Owls\)](#).

Comment [LVD26]: 26. This is an important reference to add here. Van Lanen, N. J., A. B. Franklin, K. P. Huyvaert, R. F. Reiser and P. C. Carlson. 2011. Who hits and hoots at whom? Potential for interference competition between barred and northern spotted owls. Biological Conservation 144: 2194–2201.

Comment [LVD27]: 27. "Territory size" – the area actively defended, which is a relatively small portion of the total home range, seems to be relatively constant. It is the home range that tends to be more variable.

Comment [LVD28]: 28. I don't think you need this statement since I don't think there are any exceptions to the home range being larger than the core area and defended territory.

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575 Northern Spotted Owl home ranges generally have a greater amount of older forest near the nest and
576 within the core area use, and more diverse forest types and ages on the periphery of their ranges
577 (Swindle et al. 1999).

578 Estimates of annual home range size vary across the Northern Spotted Owl's range. The 1990
579 Conservation Strategy for Northern Spotted Owls (Thomas et al. 1990) reports median annual home
580 range size of owl pairs in various study areas throughout the species' range. Table 2 summarizes home
581 range estimates across the range of the Northern Spotted Owl. Home range estimates from various
582 studies are reported using different analytical tools (e.g., Minimum Convex Polygon, Modified Minimum
583 Convex Polygon, Fixed Kernal, and Adaptive Kernal) and are identified as such in Table 2. Median home
584 range sizes in Oregon and Washington varied from a low of 1411 acres in the mixed conifer forests of
585 the Klamath Mountains (South Umpqua) to a high of 9930 acres in Washington's Olympic Peninsula,
586 consisting mostly of western hemlock with Douglas-fir (Thomas et al. 1990). More recently, Schilling et
587 al. (2013) documented considerably smaller home range sizes in southwestern Oregon's mixed conifer
588 forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference
589 between breeding and nonbreeding seasons. The study showed core area size, annual home range and
590 breeding home range size increased as amount of hard edge increased (Schilling et al. 2013). In their
591 study site in the dry forests of the eastern Cascades in Washington, Forsman et al. (2015) found
592 considerable difference between breeding home range and non-breeding home range, with ranges
593 being 3.5 times larger during the fall and winter months.

594 Home range of Northern Spotted Owls may commonly overlap with those of other neighboring owl
595 pairs, suggesting indicating that the defended area (i.e., territory) is smaller than the area used for
596 foraging (Forsman et al. 1984, Solis and Gutiérrez 1990, Forsman et al. 2015). Northern Spotted Owl
597 home ranges are larger where flying squirrels are the predominant prey, in the northern portion of the
598 range, and smaller where woodrats are the predominant prey, in the southern portion of their range
599 (Zabel et al. 1995, Forsman et al. 2001). Woodrats provide twice or more the biomass of flying squirrels
600 and, and can occur at high population densities (Hamm 1995, Hughes 2005) therefore are a more
601 energetically favorable ideal prey species, which likely explains the smaller home range in the owl's
602 southern portion of the range (Ward et al 1998, Franklin et al. 2000). The portion of the home range
603 used during the breeding season can be significantly smaller than that used in the remainder of the fall
604 and winter (Forsman et al. 1984, Sisco 1990 as cited in USFWS 2011a, Forsman et al. 2015). Forsman et
605 al. (2015) attributes the larger winter home range to prey dynamics and exploratory excursions in search
606 of better habitat.

607

Comment [LVD29]: 29.Hamm, K. A. 1995. Abundance of dusky-footed woodrats in managed forests of north coastal California. M.S. Thesis, Humboldt State University, Arcata, CA. 46 p.
30.Hughes, K. D. 2005. Habitat associations of dusky-footed woodrats in managed Douglas-fir / hardwood forests or northern California. M.S. Thesis, Humboldt State University, Arcata, CA. 40 p.

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608 **Table 2.** Summary of annual home range and core home range sizes across the range of the Northern Spotted Owl. MCP = Minimum Convex Polygon, MMCP =
609 Modified Minimum Convex Polygon, FK = Fixed Kernal, and AK = Adaptive Kernal.

Area	Annual Home Range in hectares (+/- one Standard Error)				Core area in hectares	Source
	MCP	MMCP	95% FK	95% AK		
Oregon Coast	1569(463)	1018(160)				Carey et al. 1992
Oregon Coast	1108(137) to 2214(357)		842(115) to 1344(247)		87(6) to 100(5) 95% FK	Glenn et al. 2004
Oregon Coast	2272 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
Oregon Coast	2586 (median)					Thraikill and Meslow pers comm. (as reported in Thomas et al. 1990)
Oregon Coast	1693 (median)					Carey et al. 1990 (as reported in Thomas et al. 1990)
Oregon Klamath	533(58)	472(43)				Carey et al. 1992
Oregon Klamath			576(75)		94(11) 95% FK	Schilling et al. 2013
Oregon Western Cascades	3066(1080)				417(129) AK	Miller et al. 1992
Washington Eastern Cascades	3419(826)		2427(243)			Forsman et al. 2015
Washington Eastern Cascades	3669(876)					King 1993
Washington Western Cascades	2553 (median)					Various references as reported in Thomas et al. 1990
Washington Olympic Peninsula	4019 (median)					Various references as reported in Thomas et al. 1990
California Klamath	1204 to 1341 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
California Klamath	685 (median)					Solis 1983 (as reported in Thomas et al. 1990)
California Coast	786(145)			685(112)	98(22) 95% AK	Pious 1995

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610 *Dispersal*

611 As discussed above, juveniles begin to disperse in the fall, with a few individuals beginning to disperse in
612 early winter. Juvenile dispersal from the parental territory occurs in stages, as juveniles may temporarily
613 settle in locations for up to 7 months before moving on to another temporary location, which may occur
614 several times before individuals establish a territory of their own (Miller et al. 1997, Forsman et al.
615 2002). LaHaye et al. (2001) found that successful juvenile California Spotted Owls often settled in
616 territories previously used by pairs or single owls, which may suggest that owls were able to use some
617 sort of cues that indicated some value of habitat quality when determining a territory of their own
618 (Buchanan 2004).

619 In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent
620 territory was between 13.5 and 14.6 km (8.4-9.1 mi) for males and between 22.9 and 24.5 km (14.2-15.2
621 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted
622 Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while
623 juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). Based on
624 recapture of 368 owls initially banded as juveniles for their study area in Humboldt and Del Norte
625 counties of coastal California, Green Diamond Resource Company reported dispersal distances of 0.8 to
626 150 km (0.5-93 miles), with a mean of 12.6 km (7.8 miles) for 179 males (one male with an unknown
627 dispersal distance) and 1.3 to 141 km (0.8-87.4 miles) with a mean of 16.6 miles for 138 females
628 (GDRC 2015). However, it should be noted that dispersal distances based on recapture data are
629 inherently biased low, because the probability of recapture decreases with the greater distance that
630 an individual moves. While the ~~only~~ majority of data available on dispersal pertains to Northern
631 Spotted Owls in Washington and Oregon, and California Spotted Owls in California, we can extrapolate
632 that Northern Spotted Owls in California act similarly, because, while the populations are genetically and
633 geographically distinct, they still share many ecological and behavioral characteristics.

634 Juvenile Northern Spotted Owls experience high mortality rates (>70% in some areas) during dispersal
635 due to a variety of factors including starvation, predation, and vehicle strikes (Miller 1989, Franklin et al.
636 1999, USFWS 1990, Forsman et al. 2002). Habitat type used during dispersal may also have an effect on
637 mortality. Miller et al. (1997) found that the probability of mortality decreased when dispersing
638 juveniles utilized open sapling forests, but increased when clear cuts were utilized. Successful juvenile
639 dispersal likely depends on locating suitable nesting, roosting and foraging habitat in proximity to other
640 occupied sites or among occupied sites (LaHaye et al. 2001), as well as the presence of suitable habitat
641 to disperse through (Miller et al. 1997, Buchanan 2004).

642 **Habitat Requirements**

643 Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western
644 hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and
645 redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally
646 use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al.

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1990, Carroll and Johnson 2008, Carroll 2010, USFWS 2011); however, younger forest stands with structural components similar to older forests may also be used by Spotted Owls (USFWS 2011a). The edge between old-growth forest and other vegetation types have also been shown to be important habitat components in portions of the owl's range where dusky-footed woodrats are a primary prey species (Franklin et al. 2000).

Throughout the Northern Spotted Owl's range in Washington, Oregon, and California, Bart and Forsman (1992) found owls were about 40 times more common in areas with older forest compared to areas lacking older forest. However, it should be noted that their data (Bart and Forsman 1992) may be skewed because it did not include the large number of spotted owl activity centers that were subsequently found during surveys of commercial timberlands in northwestern California. In Western Oregon, Meyer et al. (1998) determined that random owl sites contained more old-growth forest than random locations on the neighboring landscape. In Northwestern California, Northern Spotted Owls used old-growth with a higher frequency relative to this forest age class' distribution on the landscape, and similarly, used intermediate to young forests with a lower frequency (Solis and Gutiérrez 1990 and Thome et al. 1999).

Discussions on habitat components below address range-wide knowledge of Northern Spotted Owl habitat, as well as knowledge of owl habitat specific to California. This report addresses habitat requirements with a focus on major geographic provinces in California. When considering the enormous amount of research on Northern Spotted Owl habitat, careful consideration should be given to California-specific research when evaluating habitat requirements for the species in the state, and in forming conservation and management decisions.

Nesting and Roosting Habitat

Habitat selection has largely been evaluated for nesting and roosting habitat by comparing habitat surrounding occupied Spotted Owl sites to randomly selected sites (Solis and Gutiérrez 1990, Bart and Forsman 1992, Hunter et al. 1995, Thome et al. 1999). Descriptions of nesting and roosting habitat were provided in the early- to mid- 1990s (Solis and Gutiérrez 1990, Thomas et al. 1990, Bart and Forsman 1992) and have been validated by extensive research across most of the range of Northern Spotted Owl (Gutiérrez et al. 1995, Hunter et al. 1995, Meyer et al. 1998, Lahaye and Gutiérrez 1999, Swindle et al. 1999, Weathers et al. 2001, Courtney et al. 2004, USFWS 2008a, USFWS 2011a).

The following description of nesting and roosting habitat from the Conservation Strategy for the Northern Spotted Owl (Thomas et al. 1990) remains an accurate portrayal of what we know today throughout the range of the owl:

“With the exception of recent studies in the coastal redwoods of California, all studies of habitat use suggest that old-growth forests are superior habitat for northern Spotted Owls. Throughout their range and across all seasons, spotted owls consistently concentrated their foraging and roosting in old-growth or mixed-age stands of mature and old-growth trees. Exceptions were found, but even they tended to support the usual observations that spotted owls nested in

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684 stands with structures characteristic of older forests....Structural components that distinguish
685 superior spotted owl habitat in Washington, Oregon, and northwestern California include: a
686 multilayered, multispecies canopy dominated by large (>30 inches dbh) conifer overstory trees,
687 and an understory of shade-tolerant conifers or hardwoods; a moderate to high (60-80 percent)
688 canopy closure; substantial decadence in the form of large, live coniferous trees with
689 deformities- such as cavities, broken tops, and dwarf mistletoe infections; numerous large
690 snags; ground cover characterized by large accumulations of logs and other woody debris; and a
691 canopy that is open enough to allow owls to fly within and beneath it."

692 Although this habitat description accurately describes high quality nesting and roosting habitat
693 throughout the range of the Northern Spotted Owl, recent research has shown that Spotted Owls in
694 California and portions of southwest Oregon use a more diverse set of forest types for foraging. This is
695 described more fully in the Foraging Habitat section of this report.

696 Forested stands with a higher degree of complexity and a high canopy closure are thought to be
697 preferred for nesting and roosting, in part, because they provide protection from predators and thermal
698 exposure (Weathers et al. 2001, Franklin et al. 2000). Hunter et al. (1995) determined nest and roost
699 sites occurred more frequently in mature and old-growth forest in northwestern California (Willow
700 Creek Study Area) relative to availability of these forest types' on the landscape. Both nest and roost
701 sites had similar amounts of mature and old-growth forest types. Whereas sites used for nesting and
702 roosting in the coastal forests of California often contain younger trees than more interior nesting and
703 roosting sites. In the California Coast Province, young redwood forests along the coast have structural
704 complexity similar to that of older forests elsewhere in the Northern Spotted Owl's range. This is due to
705 stump-sprouting and the rapid growth rates of redwoods, together and variable timber management
706 practices (Thomas et al. 1990, Thome et al. 1999, [Folliard et al. 2000](#), USFWS 2011a, Irwin et al. 2013).

707 Small-scale spatial habitat requirements in the immediate vicinity of the nest are important but not
708 sufficient to support all activities (e.g., roosting and foraging) conducted at the larger spatial scale
709 (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, [Diller et al. 2010](#), USFWS 2011a).
710 Consequently, nesting and roosting habitat is often only a small portion of the entire home range
711 (Forsman et al. 1984, Solis and Gutiérrez 1990, USFWS 2011a).

712 To assess the success of the coordinated forest management plan for federal lands, the Northwest
713 Forest Plan (NWFP; see Northwest Forest Plan section of this report), Davis et al. (2011) developed a
714 habitat suitability map for nesting and roosting habitat across the Northern Spotted Owl range (Figure
715 4). The habitat suitability model was developed using MaxEnt model output, including variables for
716 percent conifer cover, average conifer dbh, amount of large conifer (trees >30 in dbh per acre),
717 diameter diversity, average stand height, and average stand age. Much of the highest suitable habitat is
718 within northwestern California (inclusive of the northern most portion of the California Coast Province
719 and the western portion of the California Klamath Province) and [along the coastal forests](#).

Comment [LVD30]: 31.Reference that should be added relative to NSO nesting in the redwood region. Folliard, Lee B., Kerry P. Reese and Lowell V. Diller. 2000. Landscape characteristics of northern spotted owl nest sites in managed forests of northwestern California. The Journal of Raptor Research 34(2):75-84.

Comment [LVD31]: 32.This contradicts the notion that old growth is the best habitat for spotted owls since this region has little old growth and is predominately managed private timberlands. This also seems to contradict the modeling effort done by Schumaker et al. which suggested that the coastal area was sink habitat.

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720 *Foraging Habitat*

721 Compared to nesting and roosting habitat, foraging habitat occurs over a much larger portion of the
722 Northern Spotted Owl's home range, often quite distant from the nesting or roosting site. Within a
723 Spotted Owl home range, foraging habitat use may vary seasonally, with a larger area and younger
724 forests used in the non-breeding period (Forsman et al. 1984, Solis and Gutiérrez 1990, USFWS 2011a).
725 Overall foraging habitat consists of areas where the prey species occur and are available (Ward 1990,
726 Zabel et al. 1995).

727 In California, foraging habitat is generally composed of a more diverse set of forest types and structural
728 characteristics than nesting and roosting habitat. Spotted Owls are difficult to observe during nighttime
729 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and
730 roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry
731 studies that document owl locations throughout nighttime movements. Although it is difficult to
732 determine when and where owls are actually obtaining prey, telemetry does provide information on the
733 diversity of forest types used during foraging excursions.

734 There is a general shift in foraging habitat requirements from north to south within the Northern
735 Spotted Owl range, with foraging habitat in the northern portion of the range being composed of mostly
736 older forests, and in California being composed of a diverse range of forest types from mature to
737 relatively young (USFWS 2009). In the northern portion of the Northern Spotted Owl range where flying
738 squirrels are the dominant prey, foraging habitat may have the same characteristics as nesting and
739 roosting habitat (Gutiérrez 1996, USFWS 2011a). Whereas in the southern portion of their range, where
740 woodrats and voles are the predominant prey species, foraging habitat may include tanoak, oak and
741 younger conifer stands that provide a food source for these prey species (Franklin et al. 2000, USFWS
742 2009, [Diller et al. 2010](#)).

743 Landscape-level analyses in portions of the Klamath Province, where woodrats are the main prey item,
744 suggest that a mosaic of late-successional forests intermixed with various other seral stages may benefit
745 Northern Spotted Owls more than large uniform blocks of older forests (Meyer et al. 1998, Franklin et al.
746 2000, Zabel et al. 2003, [Diller et al. 2010](#)). Irwin et al. (2012) found in Oregon and northwestern
747 California that Northern Spotted Owl foraging habitat appeared to be maximized in patches of trees
748 with average quadratic mean diameter¹ of 40 to 55 cm (15-22 inches). Probability of an area being
749 selected for foraging declined rapidly beyond 200 to 300 m (0.12-0.19 miles) from a nest site, yet
750 increased with basal area of hardwoods and with increases in shrub counts (except in areas with high
751 abundance of hardwoods and shrubs).

Comment [LVD32]: 33.I don't know of anyone even trying except for a study using night vision scopes on Green Diamond. The results are somewhat equivocal due to the inherent biases of trying to make direct observations, but it did provide some useful insights into NSO foraging. Results are reported in Diller et al. 2010.

¹ Compared to the arithmetic mean, quadratic mean diameter, or QMD, assigns greater weight to larger trees. QMD is always greater than or equal to the arithmetic mean for diameter at breast height for a given set of trees.

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Within the northern Sierra Nevada Mountains, similar to the mixed conifer Cascade mountain range, Irwin et al. (2007) used radio-telemetry data to assess foraging use parameters of California Spotted Owls. Topography, forest density and heterogeneity, and tree species composition all influenced foraging habitat selection, which in this case was driven by the habitat of the preferred prey, dusky-footed woodrat. Foraging was closely associated with forest stands next to nests and small streams at lower elevations. Intermediate basal area values (35-55 m²/hectares) for Douglas-fir, white fir, and red fir and hardwoods ≥20 cm (≥8 inches) were all positively correlated to foraging habitat use. Owls foraged in sites with an average tree density of 1160 trees/hectare, foraged in stands with 17 large green (>66 centimeter or >26 inch diameter) trees/ha. Use declined with increasing basal area of ponderosa pine. Foraging areas were not strongly associated with roads, slope or aspect.

As noted previously in this report, several studies have shown a benefit of edge habitat for Northern Spotted Owls, as certain habitat types that border older forest may contain higher numbers of preferred prey, the dusky footed woodrat, and surplus prey may venture into older forests that border habitat where prey is abundant making them more available to foraging owls (Zabel et al. 1995, Thome et al. 1999, Franklin et al. 2000, [Diller et al. 2010](#), Franklin et al. 2013). For instance, Zabel et al. (1995) often found Spotted Owls foraging near transitions between early- and late-seral stage forests stands in northern California, likely where prey species were more abundant or more readily available. [While most studies have suggested that woodrats living in young stands are taken only when they disperse into adjacent older stands, a study in coastal California using night vision scopes indicated that at least some owls used perches in young open stands for foraging \(Diller et al. 2010\).](#)

Franklin et al. (2000) conducted a modeling effort in northwestern California to help explain variation in both apparent survival and reproductive output. The study found that one of the best models contained a covariate representing the amount of edge between Spotted Owl (defined in the study as mature and old-growth forests with particular characteristics) and other habitats, thereby suggesting that reproductive output and survival are positively influenced by amount of edge, presumably due to increased availability of prey. [Similarly, a study conducted immediately to the west of Franklin et al. \(2000\) in the redwood region, provided highly comparable results with the best habitat supporting both survival and fecundity had a mix of young and older stands with greater amounts of edge \(Folliard et al. 2000, Diller et al. 2010\).](#) However, foraging owls have been shown to avoid non-forested areas (e.g., recent clearcuts) and very early forest successional stages (USFWS 2011a, Irwin et al. 2013).

Dispersal Habitat

Generally, it is well accepted that dispersal habitat for Northern Spotted Owls consists of stands with adequate tree size and canopy closure to provide protection from avian predators and that have at least minimal foraging opportunities (Miller et al. 1997, Thomas et al. 1990, Forsman et al. 2002, Buchanan 2004, USFWS 2011a). This may include younger forest stands with less diversity than nesting and roosting habitat, such as even-aged and pole stands, but should at the minimum contain some roosting structures and foraging habitat during this transient stage (Davis et al. 2011, USFWS 2011a). [The latest meta-analysis \(Forsman et al. 2011\) indicates that recruitment of owls into the breeding population likely depends on the amount and quality of dispersal habitat to ensure survival of dispersing owls.](#)

Comment [LVD33]: 34. This is no longer the latest. Dugger et al. (*In press*) has been accepted by Condor so it becomes the latest

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791 Spotted Owls have been shown to disperse through highly fragmented forest landscapes and seem to
792 use mature and old-growth forests more than that forest type’s availability on the landscape during this
793 phase (Miller et al. 1997, Forsman et al. 2002). The USFWS (USFWS 2011) states that corridors of
794 dispersal habitat within fragmented landscapes act to facilitate rapid movement to areas of better
795 habitat. There is little evidence that small openings in forest habitat influence the dispersal of Spotted
796 Owls, but large non-forested valleys may act as barriers to both natal and breeding dispersal (Forsman
797 et al. 2002). Water bodies may also function as barriers to dispersal, but this is not clearly understood
798 (Forsman et al. 2002).

799 Thomas et al. (1990) suggests juvenile movement corridors need not be provided on the landscape
800 outside of areas managed as nesting and roosting habitat if 50% of the forest measured on a quarter
801 township basis is forested by trees with average diameter >11 inches and >40 percent canopy closure
802 (i.e., the 50-11-40 rule). Regarding this rule, the USFWS Recovery Plan (2011) states, “the minimum
803 levels of this definition describe habitat supporting the transient phase of dispersal.”

804 A clear understanding of dispersal habitat is key to the management of owl habitat across the Northern
805 Spotted Owl’s range. Buchanan (2004) stressed the importance of appropriate management of dispersal
806 habitat and suggests that one of the greatest inadequacies of Spotted Owl habitat management is the
807 lack of retention of structurally complex forest components, such as snags and downed woody debris, at
808 the time of or post timber harvest. Additional studies in California, such as radio telemetry on juvenile
809 owls, prey abundance and availability, and habitat modeling, are required in order to elucidate specific
810 habitat requirements for and barriers to dispersal.

811 In an attempt to document the level of change in dispersal habitat, Davis et al. (2011) developed
812 dispersal habitat maps for 1994-2007 using Global Information Systems (GIS), using variables for conifer
813 dbh ≥11 inches and conifer cover ≥40 percent (Figure 5). The maps also included some amount of
814 nesting and roosting habitat since owls will disperse through these habitat types. Dispersal habitat is
815 continuous in large portions of the northern range in California, with small isolated patches north of
816 Point Arena and in Marin County, in the California Coast Province.

817 *Northern Spotted Owl Habitat Descriptions for Geographic Provinces in California*

818 The forest types within the California range are quite diverse, and consequently, Northern Spotted Owls
819 use the habitat differently among these forest types. Historically the range of the Northern Spotted Owl
820 has been separated into 12 physiographic provinces based on differences in vegetation, soils, geologic
821 history, climate, land ownership and political boundaries (USFWS 2011a; Figure 1); of which three
822 provinces are in California – California Coast, California Klamath, and California Cascade. To better
823 understand the range of forest types used and regional differences that influence habitat quality in
824 California, general owl habitat within each province is described below.

825 In addition to province segregations, habitat modeling conducted for the 2011 Revised Recovery Plan
826 (USFWS 2011a) identified 11 modeling regions range-wide, five of which occur in California (Figure 6).
827 These modeling regions were developed to capture regional differences in forest environments in

Comment [LVD34]: 35.I don’t understand the basis for this assertion. I don’t know of any study that has shown NSO populations are limited by dispersal habitat. When you look at Figure 4, it appears that the amount and distribution of marginal/suitable/highly suitable nesting and roosting habitat in CA is sufficient to provide adequate dispersal opportunities. The only barriers appear to be non-forested areas. Relative to CA, it doesn’t seem that a separate definition of dispersal habitat is even relevant given the amount of roosting and nesting habitat.

Comment [LVD35]: 36.I agree that this would be very interesting from a scientific standpoint, but I am not sure it would ever be a management priority without some evidence that dispersal capabilities are limiting for NSO.

Comment [LVD36]: 37.This supports the statements above – dispersal habitat doesn’t appear to be limiting.

Comment [LVD37]: 38.This seems to suggest that possibly roosting and nesting habitat is only marginal dispersal habitat. Given that roosting and nesting habitat tends to be structurally complex older forest, how can you get any better habitat for a dispersing juvenile owl? Obviously, there also needs to be foraging habitat, but foraging habitat tends to be more diverse and spatially available than roosting and nesting habitat.

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acknowledgement of the fact that Northern Spotted Owls exhibit different habitat associations in various portions of their range, and focused on differences in habitat rather than political boundaries or ownership type. For this reason, four of the five modeling regions in California extend into Oregon where similar habitat occurs. Modeling regions that overlap with the California Coast, California Klamath and California Cascade provinces are described below under the appropriate province description.

California Coast Province

A description of the California Coast province is noted below, as defined in the 1992 Northern Spotted Owl recovery plan (USFWS 1992):

“The California Coast province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of national forest lands. The coastal part of the province encompasses the majority of the redwood forest habitat type. Inland forests are Douglas-fir and mixed Douglas-fir/hardwood types, the latter often interspersed with chaparral and grasslands.”

Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) are included in the California Coast Province, the Redwood Coast (RDC) and Interior Coast (ICC) regions. The RDC is described below:

“This region is characterized by low-lying terrain (0 to 900 m) with a maritime climate; generally mesic conditions and moderate temperatures. Climatic conditions are rarely limiting to Spotted Owls at all elevations. Forest communities are dominated by redwood, Douglas-fir-tanoak forest, coast live oak, and tanoak series. The vast majority of the region is in private ownership, dominated by a few large industrial timberland holdings. The results of numerous studies of Spotted Owl habitat relationships suggest stump-sprouting and rapid growth rates of redwoods, combined with high availability of woodrats in patchy, intensively-managed forests, enables Spotted Owls to maintain high densities in a wide range of habitat conditions within the Redwood zone. This modeling region contains the Green Diamond and Marin DSAs [density study areas].” (USFWS 2011a, pg C-9 and C-10).

Along the coast of northwestern California young redwood and mixed conifer-hardwood stands appear capable of supporting higher densities of Spotted Owls than younger forests in other regions. This is particularly the case in areas where young hardwood forests provide a multilayered structure (Thomas et al. 1990, Diller and Thome 1999) within a conifer stand. It is important to note here (and is discussed later in the document) that density estimates are not necessarily linked with high quality habitat (i.e. habitat conferring both high survival and fecundity/reproductive success).

In young growth coastal forests with a negligible amount of old-growth stands (>200 yr) in Humboldt and Del Norte counties, Diller et al. (2012) [Thome et al. (1999)] found, when active at night, Northern Spotted Owls were most likely to be found in older more complex forest stands that were in close proximity to younger stands that have high densities of woodrats positively associated with middle-aged stands (21-40 years old) that contained larger trees and higher proportions of stands with the largest basal area class (>69 m²/ha), and negatively associated with younger stands that contained smaller

Comment [LVD38]: 39. “Reproductive success” is a more specific term related to the proportion of breeding adults that produce young. “Fecundity” is a more appropriate in this context because it is a more inclusive term that is based on the average number of young produced by all females in the population.

Comment [LVD39]: 40. There have been three analyses of habitat data for the Green Diamond study area: Folliard 1993 (MS thesis based on 60 owl sites) a portion of which was published in Folliard et al. 2000, Thome 1997 (MS thesis based on 51 owl sites), which was published in Thome et al. 1999, and a comprehensive analysis of all the habitat data in Diller et al. 2010 (2 years of telemetry on 28 owls and 11 years of data on 173 nests), which was also summarized in Diller et al. 2012. Rather than trying to summarize the results of each, it makes sense to use the final synthesis that was published in Diller et al. (2012) to represent what is known about NSO habitat on the Green Diamond study area.

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trees. The top nesting model for this managed timberlands indicated that the relative probability of locating a successful nest increased with age of the nest stand and 'edge density' (i.e., habitat heterogeneity) within a 600 m radius of the nest. In addition, nest selection was greatest in stands with approximately 55 percent basal area of residual older trees, 30 percent evergreen hardwood basal area and a large amount of foraging habitat within a 400 m radius of the nest (Diller et al. 2012). This indicated that for nesting, spotted owls were selecting older more complex stands that were in fairly close proximity to areas that had a high potential as foraging habitat. Irwin et al. (2013) found that Northern Spotted Owls used patches with more large trees and greater basal area within two study areas in the coastal redwood zone (Fort Bragg and Eureka). It is thought that stump-sprouting and rapid growth rates of redwoods, together with readily available prey (mainly woodrats) and patchy intensively managed stands (e.g., small-patch clearcuts), allows owls to occupy this habitat in higher densities (Thomas et al. 1990, USFWS 2011a). Thome et al. (1999) found that timber management using clearcuts was associated with low reproduction, and therefore recommended clearcuts be restricted to 1.1 km (0.68 mi) beyond the nest site.

The ICC differs strikingly from the adjacent coastal redwood region, and is described below:

"This region... differs markedly from the adjacent redwood coast region. Marine air moderates winter climate, but precipitation is limited by rain shadow effects from steep elevational gradients (100 to 2,400 m.) along a series of north-south trending mountain ridges. Due to the influence of the adjacent Central Valley, summer temperatures in the interior portions of this region are among the highest within the Spotted Owl's range. Forest communities tend to be relatively dry mixed conifer, blue and Oregon white oak, and the Douglas-fir-tanoak series. Spotted Owl habitat within this region is poorly known; there are no DSAs and few studies have been conducted here. Spotted Owl habitat data obtained during this project suggests that some Spotted Owls occupy steep canyons dominated by live oak and Douglas-fir; the distribution of dense conifer habitats is limited to higher-elevations on the Mendocino National Forest." (USFWS 2011a, pg C-12, C-13)

The southern limit of the owl's range in Marin County (part of the California Coast Province and inclusive of both RDC and ICC regions) contains coast redwood, Bishop pine (*Pinus muricata*) and Douglas-fir forests and mixed evergreen-deciduous hardwood forests (e.g., California bay, tanoak and coast live oak) which are regularly used by Spotted Owls (Jenson et al. 2006, USFWS 2011a). Stralberg et al. (2009) found that owls inhabiting Marin County mixed forests were equally likely to be found in conifer dominated stands as they were be to found in hardwood dominated stands, and were negatively affected by habitat fragmentation, yet there did not seem to be a preference for any one tree species when considering owl nest site occurrence. The higher densities of owls and high reproductive success in Marin County may be an indication of a more generalist nature of Marin owls when it comes to habitat selection and the high abundance of woodrats in this area, in contrast to other areas within the Northern Spotted Owl's range in California (Press et al. 2012). The higher use of nest platforms (rather than nest cavities) in the Marin County population is similar to the ratio seen in other younger aged forests, such as in the eastern Cascade Mountains in Washington (Jenson et al. 2006). LaHaye and Gutiérrez (1999) suggested nest type selection depends on the age of the forest, which is supported for

Comment [LVD40]: 41.I agree with this conclusion, but it is missing the importance of stump-sprouting evergreen hardwoods such as tanoak, madrone and California bay. As noted above (Diller et al. 2012), nest sites tended to be associated with areas of substantial amounts of these hardwoods, which not only help create structurally complex stands but also support a more diverse prey base.

Comment [LVD41]: 42.This conclusion was not supported with analysis of additional nest sites.

Comment [LVD42]: 43.I am not sure these densities are comparable to other studies because I believe they were only considering ecological densities and the forested land in this region tends to be isolated to narrow canyon bottoms.

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the Marin County population where both logging and fire have resulted in younger-aged forests (Jenson et al. 2006).

California Klamath Province

A description of the California Klamath province is noted below, as defined in the 1992 Northern Spotted Owl recovery plan (USFWS 1992):

“The California Klamath province is between the California Coast province and the California Cascades province. It is a continuation of the Oregon Klamath province, south to the Clear Lake Basin in the inner Coast Range. The area is mountainous and covered primarily with Douglas-fir forests. Mixed Douglas-fir/pine forests are common at lower elevations with Douglas-fir/true fir forests at higher elevations.”

Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) make up the majority of the California Klamath Province, the Western Klamath (KLW) and Eastern Klamath (KLE) regions. The ICC modeling region, which is described above, represents a relatively small southern portion of the California Klamath province. The KLW is described below:

“A long north-south trending system of mountains (particularly South Fork Mountain) creates a rain shadow effect that separates this region from more mesic conditions to the west. This region is characterized by very high climatic and vegetative diversity resulting from steep gradients of elevation, dissected topography, and the influence of marine air (relatively high potential precipitation). These conditions support a highly diverse mix of mesic forest communities such as Pacific Douglas-fir, Douglas-fir tanoak, and mixed evergreen forest interspersed with more xeric forest types. Overall, the distribution of tanoak is a dominant factor distinguishing the Western Klamath Region. Douglas-fir dwarf mistletoe is uncommon and seldom used for nesting platforms by Spotted Owls. The prey base of Spotted Owls within the Western Klamath is diverse, but dominated by woodrats and flying squirrels. This region contains the Willow Creek, Hoopa, and the western half of the Oregon Klamath DSAs.” (USFWS 2011a, pg C-12)

The KLE differs from KLW by the reduced influence of marine air and a slightly varying forest composition. The KLE is described below:

“This region is characterized by a Mediterranean climate, greatly reduced influence of marine air, and steep, dissected terrain. Franklin and Dyrness ([1973]) differentiate the mixed conifer forest occurring on the “Cascade side of the Klamath from the more mesic mixed evergreen forests on the western portion (Siskiyou Mountains), and Kuchler (1977) separates out the eastern Klamath based on increased occurrence of ponderosa pine. The mixed conifer/evergreen hardwood forest types typical of the Klamath region extend into the southern Cascades in the vicinity of Roseburg and the North Umpqua River, where they grade into the western hemlock forest typical of the Cascades. High summer temperatures and a mosaic of open forest conditions and Oregon white oak woodlands act to influence Spotted Owl

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942 distribution in this region. Spotted Owls occur at elevations up to 1768 m. Dwarf mistletoe
943 provides an important component of nesting habitat, enabling Spotted Owls to nest within
944 stands of relatively younger, small trees. The western half of the South Cascades DSA and the
945 | eastern half of the Klamath DSA are located within this modeling region.” (USFWS 2011a, pg C-
946 12)

947 As mentioned above, Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) provides an important
948 component of nesting habitat, enabling Northern Spotted Owls to nest within stands of relatively
949 | younger small trees (USFWS 2011a). Its distribution coincides with the distribution of Douglas-fir from
950 southern British Columbia to central Mexico (Hadfield et al. 2000).

951 The propensity for Northern Spotted Owls to utilize old structurally complex forests in the California
952 Klamath Province for nesting and roosting is supported by numerous studies on public and private
953 timberlands. Table 3 provides a detailed summary of habitat studies in the Klamath Province. Foraging
954 habitat may contain the typical older forest components of nesting and roosting habitat, but may also
955 include younger forests, hardwood stands, and more open areas (Solis and Gutiérrez 1990, Zabel et al.
956 1995, Irwin et al. 2012, Irwin et al. 2013).

957

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958 **Table 3.** Description of suitable habitat from studies of Northern Spotted Owl habitat relationships in the Klamath
959 Province (partially adapted from USFWS 2009, Table III.C.1).

Study	Location	Method	Description of Selected or Suitable Habitat
USFWS 1992, Bart 1995	Washington, Oregon, northern California	research synthesis (various methods)	conifer-dominated forest with a multi-layered canopy, average DBH1 >30 inches, >60% canopy cover, decadence (snags, logs, deformed trees)
Anthony and Wagner 1999	southwestern Oregon	aerial photographs, ground reconnaissance	conifer-dominated forest with a multi layered canopy, >40% canopy cover, decadence, large snags and logs; characterized by trees >30 inches DBH and >200 yrs
Blakesley et al. 1992	northwestern California	ground sampling, USFS timber stratum maps	coniferous forest characterized by trees >53.3 cm in diameter, forests at 300-900 m elevations for roosting, and the lower third of slopes within a specific drainage
Carey et al. 1992	southwestern Oregon	aerial photographs, forest inventory data, ground reconnaissance	multi-layered canopy, average DBH of dominant trees >39.4 inches, large snags and logs
Dugger et al. 2005	southwestern Oregon	aerial photographs, ground reconnaissance	conifer or mixed forest, >100 yrs; characterized by trees >13.8 inches DBH
Franklin et al. 2000	northwestern California	satellite imagery	forest comprised of >40% conifers, conifer QMD2 >21 inches, hardwood QMD >6 inches, canopy cover >70%
Gutiérrez et al. 1998	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Hunter et al. 1995	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Irwin et al. 2012	southwestern Oregon and northcentral California	ground sampling, modeling	Selection tied to increasing average diameter of coniferous trees and also with increasing basal area of Douglas-fir trees, increased with increasing basal areas of sugar pine hardwood trees and with increasing density of understory shrubs. Large-diameter trees (>66 cm) appeared important <400 m from nest sites.
Irwin et al. 2013	southwestern Oregon and northcentral California	forest inventory from private and federal landowners, modeling	Basal area (m ² /ha) between 35-60 in nesting period, and 30-54 in winter period, basal area of trees >66 cm was between 7-22 in nesting period, and 7-18 in winter period, QMD 37-60 in nesting period and 37-61 in winter period.
LaHaye and Gutiérrez1999	northwestern California	ground sampling	83% of nests located in Douglas-fir, 60% of nests located in brokentop trees, nest within forests characterized by large (> 90 cm dbh) conifers, a hardwood understory, and a variety of tree

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			sizes.
Meyer et al. 1998	western Oregon	aerial photographs	conifer-dominated forest, trees >80 yrs and/or multi-layered canopy
Ripple et al. 1997	southwestern Oregon	aerial photographs	conifer-dominated forest, average DBH >19.7 inches, canopy cover >60%
Solis and Gutiérrez 1990	northwestern California	timber type classification	average DBH >20.7 inches
Zabel et al. 1993	northwestern California	topographic maps, aerial photographs, and orthophotoquads	stands dominated (in terms of basal area) by trees >20.9 inches DBH; >20% canopy cover of dominant trees and >70% canopy cover of trees >5.1 inches DBH
Zabel et al. 2003	northwestern California	modified timber type classification, varied geographically	<u>nesting-roosting habitat</u> : for most locations average DBH >17 inches and average conifer canopy cover >60%; <u>foraging habitat</u> : in all locations average DBH >9.8 inches and average conifer canopy cover >40%, additional criteria in some locations

960

961 California Cascade Province

962 A description of the California Cascades province is noted below, as defined in the 1992 Northern
963 Spotted Owl recovery plan (USFWS 1992):

964 “The California Cascades province is bordered by the Oregon Cascades province, the Oregon and
965 California Klamath provinces, and the north end of the Sierra Nevada. It is the link between the
966 range of the northern Spotted Owl and the range of the California Spotted Owl. Suitable owl
967 habitat, which is fragmented on a broad scale by high- and low-elevation areas containing
968 marginal habitat, is predominately in two national forests. However, there are significant blocks
969 and checkerboard ownership areas where industrial private lands can provide suitable habitat.”

970 | One modeling region described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) makes
971 up the majority of the California Cascades province, Eastern Cascade - South (ECS). The ICC modeling
972 region, which is described above, represents a relatively small southern portion of the California
973 Cascades province. The ECS is described below:

974 “Topography is gentler and less dissected than the glaciated northern section of the eastern
975 Cascades. A large expanse of recent volcanic soils (pumice region: Franklin and Dyrness [1973]),
976 large areas of lodgepole pine, and increasing presence of red fir and white fir (and decreasing
977 grand fir) along a south-trending gradient further supported separation of this region from the
978 northern portion of the eastern Cascades. This region is characterized by a continental climate
979 (cold, snowy winters and dry summers) and a high-frequency/low-mixed severity fire regime.
980 Ponderosa pine is a dominant forest type at mid-to lower elevations, with a narrow band of

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981 Douglas fir and white fir at middle elevations providing the majority of Spotted Owl habitat.
982 Dwarf mistletoe provides an important component of nesting habitat, enabling Spotted Owls to
983 nest within stands of relatively younger, smaller trees.” (USFWS 2011^a, pg C-11, C-12)

984 Compared to other provinces in California, very little is known about the specific needs of the Northern
985 Spotted Owl in the California Cascades. In addition, no studies have been conducted to date evaluating
986 habitat quality (the amount and type of habitat most beneficial to owls) across owl sites in the California
987 Cascade Province. Recent telemetry work on foraging habitat use and selection has been conducted on
988 three large study areas at the interface of the southern Cascades and eastern Klamath Mountains in
989 southern Oregon and north-central California (Irwin et al. 2012, 2013). These studies provide valuable
990 information on foraging habitat use in the California Cascade region, but without demographic
991 performance information the results have limited utility for identifying the habitat’s quality for owls.

992 Irwin et al. (2012 and 2013) found that Northern Spotted Owls in Oregon and northwestern California
993 selected areas with greater density and basal area of trees >66 cm dbh (>26 dbh) within 400 m (0.25 mi)
994 of nest sites. The authors suggest a plausible optimal landscape for Spotted Owls in the region might
995 include stands of large-diameter trees near nest sites which are embedded in a heterogeneous forest
996 landscape of various selected foraging types. Modeling owl habitat based upon characteristics used
997 during nighttime foraging excursions, Irwin et al. (2012) found that owls selected mixed-aged and mixed
998 coniferous forest stands. In this study, the Yreka study site was inclusive of dry forest types on the
999 California Cascade Province.

1000 In a modeling effort within the Klamath and Cascade provinces, habitat parameters were compared
1001 among all forest types within the owls range in California, Oregon and Washington (considered habitat
1002 across the entire range at the time) with that of California-specific knowledge of owl habitat within
1003 Klamath and Cascade provinces (Zabel et al. 2003). These revised parameters considered new nesting,
1004 roosting and foraging habitat types and attributes (e.g., younger trees, elevation, aspect, California-
1005 specific soil classes) that the range-wide habitat map left out. The revised model performed better at
1006 predicting owl occupancy in California’s interior forest types than the range-wide model. The study
1007 concluded that modeling California habitat independent of range-wide habitat was more effective at
1008 predicting owl occupancy and numbers in California interior forest types.

1009 *Habitat Effects on Survival and Reproduction*

1010 | Habitat quality has been evaluated in a number of ways including: assessing population density of owls
1011 in different habitat types, comparing vital rates between owl sites with different habitat conditions,
1012 modeling vital rates for populations of owls across broad areas that exhibit differences in landscape
1013 scale forest composition, and modeling vital rates at individual owl territories with specific forest
1014 structure and composition. The type, extent, and spatial configuration of forests in a high quality
1015 territory vary across the range of the Northern Spotted Owl and across regions of California. Although
1016 many different combinations of habitat can support a productive Northern Spotted Owl pair with high
1017 fitness, the body of evidence suggests minimum thresholds for amounts and distributions of various
1018 forest types within any given Northern Spotted Owl home range.

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1019 In the most recent ~~broad demographic meta-analysis~~ of all eleven demographic study areas throughout
1020 the range of the Northern Spotted Owl (Figure 7) (Forsman et al. 2011, Dugger et al. In press), habitat
1021 variables were evaluated for effect on fecundity, survival, and rate of population change. ~~Habitat data~~
1022 ~~were not available for California, and so effect of habitat on demographic rates could only be evaluated~~
1023 ~~for Oregon and Washington.~~ In all Oregon study areas, modeling revealed strong evidence for an effect
1024 of suitable habitat on fecundity. Four of five Oregon study areas showed declines in fecundity with
1025 decreases in suitable habitat, however, the Klamath study area of southwest Oregon showed the
1026 opposite relationship, with fecundity declining with increases in suitable habitat. The latter result is
1027 consistent with one territory-based analyses in the Klamath province in California which showed an
1028 increase in fecundity with decreases in mature forest (Franklin et al. 2000), but is inconsistent with a
1029 territory-based analysis in the Klamath province of southern Oregon (Dugger et al. 2005). An additional
1030 study in southern Oregon, although not in the Klamath Province, also showed an increase in fecundity
1031 with decreases in mature forest (Olson et al. 2004).

Comment [LVD43]: 44.Dugger et al. (*In press*), the most recent meta-analysis that includes data through 2013 has been accepted by Condor, so the results from Forsman et al. (2011) with data through 2008 are essentially obsolete. I did not attempt to do this, but someone needs to do a search of the status review and replace where appropriate all of the results from Forsman et al. 2011 with the results from Dugger et al. In press.

1032 There was weak evidence for a relationship between the percent cover of suitable habitat and apparent
1033 survival for four study areas in Oregon and Washington (Forsman et al. 2011). This is in contrast to three
1034 territory-based analyses in California and southern Oregon which found positive relationships between
1035 survival and mature forest (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). It is likely that
1036 habitat influences demographic rates of individual spotted owls on a home range or territory scale.
1037 Therefore where finer-scale data have been available, studies conducted at the scale of owl territories
1038 are more likely to detect an effect and are likely more representative of individual Spotted Owl habitat
1039 requirements than the broad meta-analysis.

Comment [LVD44]: 45.Replace with results from Dugger et al. In press.

1040 Territory-based studies have revealed that owls occupy sites that vary in quality, with pairs exhibiting
1041 various levels of survival and productivity in association with habitat type. For example, Bart and
1042 Forsman (1992) found that Northern Spotted Owl productivity increased with increasing amount of
1043 older forests. Similarly, using turnover rates to define survival Bart and Ernst (1992) found that adults
1044 remained in a territory longer when mature and old-growth was present within the territory.

1045 Certain habitat characteristics have been shown to support high quality Northern Spotted Owl
1046 territories, with both the amount and spatial configuration of different habitat types at a territory
1047 contributing to levels of survival and productivity in the resident owls. This measure of habitat quality at
1048 the scale of Northern Spotted Owl home range has been termed "habitat fitness potential" (HFP). HFP
1049 was defined by Franklin et al. (2000) as "...the fitness conferred on an individual occupying a territory of
1050 certain habitat characteristics." and is determined by modeled values of lambda (λ ; defined as annual
1051 rate of population change²) and the rates of survival and reproduction that influence λ (Franklin et al.
1052 2000, Olson et al. 2004, Dugger et al. 2005, Diller et al. 2010). The habitat characteristics that influence
1053 HFP include the amount of nesting, roosting, and foraging habitat, as well as the amount of non-habitat.

² See section on Demographic Rates below for a discussion of lambda and fitness.

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The spatial configuration of these different habitat types around an activity center has also been shown to be important in determining HFP. Studies that have evaluated HFP vary somewhat in the size of core areas evaluated and some have evaluated a broader area representing the broader home range. Studies have occurred in southwestern Oregon and northwestern California and so represent different geographic areas, ~~and forest types,~~ primary prey and thus foraging ecology of spotted owls although most are largely in the Klamath Province of Oregon and California. The results of the Northwestern California/Willow Creek study (Franklin et al. 2000) located in portions of the north Coast Range and the Klamath Mountains in California, and the Green Diamond study (Diller et al. 2010) immediately to the west in the Redwood Coast (Figure 7) potentially have the greatest relevance for the majority of Northern Spotted Owls in California as seen in Figure 3. ~~Three~~ These four territory-based studies at study areas in the interior of California and southern Oregon have all found fairly strong associations between habitat characteristics and demographic rates of northern spotted owls (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Diller et al. 2010). These studies are summarized below and in Table 4.

Each of the ~~three~~ four studies attempted to evaluate the effect that older forests (representing nesting/roosting habitat) and other habitat components have on owl demographic rates. In addition, the Green Diamond study, designed to evaluate the effectiveness of its Habitat Conservation Plan's conservation strategy, included the effect of timber harvest and spotted owl set-aside areas on owl demographic parameters. In all cases the authors have attempted to capture habitat composed of the oldest forests in the study area to represent high quality nesting and roosting habitat, based on the strong association of the Northern Spotted Owl with mature and old-growth forests. Availability of data for each study area resulted in different definitions of nesting and roosting habitat in each study. Depending on the study, additional attributes evaluated included nonhabitat (e.g., nonforested areas), ~~and~~ amount of edge between various land cover types and non-habitat attributes such as precipitation and temperature during different portions of the owl's breeding season.

Franklin et al. (2000) modeled the relationship between owl habitat covariates in the core area of Spotted Owl home ranges and Northern Spotted Owl fitness in portions of the north Coast Range and the Klamath Mountains in California. In this study, Northern Spotted Owl habitat was defined as "mature and old-growth forest with a quadratic mean diameter of ≥ 53 cm, quadratic mean diameter of hardwoods ≥ 15 cm, percentage of conifers $\geq 40\%$, and overstory canopy coverage of $\geq 70\%$." Apparent survival increased with an increased amount of owl habitat, with the amount of edge between owl habitat and other habitat, and at intermediate distances between patches and owl habitat. There was a rapid decrease in survival when the amount of owl habitat fell below about 100 acres (40 hectares) of owl habitat within the core use area. Reproductive rate also increased with an increase of edge between owl habitat and other habitat types, but decreased with increasing amount of owl habitat. Reproductive output had a non-linear relationship with amount of owl habitat, only increasing substantially when the amount of owl habitat was less than 75 to 100 acres (30 to 40 hectares). Variation in survival was attributed mostly to habitat, whereas variation in reproductive output was attributed to both to habitat and climatic events (e.g., cold heavy rains during peak breeding season). HFP was maximized ~~in~~ at owl sites with roughly equal amounts of late seral and "other habitat" (i.e., greater amounts of what Franklin

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et al. 2000 termed “habitat heterogeneity”). These sites had sufficient owl habitat to facilitate high survival and ~~sufficient-adequate~~ edge habitat to facilitate both high survival and high reproductive output. Given this, the authors suggest that there is a trade-off between the amount of owl habitat and edge required to maximize survival and reproduction, while at the same time noting that the components of quality edge habitat are still poorly understood since the study did not discriminate between types or amount of “other habitat”. Despite the trade-off between survival and reproduction, estimates of λ have been shown to be driven by survival rates in Northern Spotted Owls (Forsman et al. 2011), and “...low amounts of spotted owl habitat within a territory will not supply the high degree of edge predicted to support high reproductive output” (Franklin et al. 2000).

The Green Diamond analysis of HFP (Diller et al. 2010) was designed to mimic the Franklin et al (2000) study and A. Franklin was consulted throughout the analysis and provided a peer-review of the final results for this US Fish and Wildlife Service report. However, there were considerable differences between the two analyses because the variables included in the analysis differed due to greater availability of stand-level habitat data for the Green Diamond study area. Furthermore, the Green Diamond HCP allowed harvesting of a limited amount of occupied owl habitat (i.e., ‘take’ of the owl site), which provided a unique opportunity to assess the direct impacts of timber harvesting on spotted owls. We also analyzed the effect of 39 no-harvest set-asides totaling 10,331 acres that were designated as part of the spotted owl conservation strategy in the HCP.

Positive habitat effects on survival were associated with increased nest site selection values (i.e., owl sites with older aged nest stand and greater edge density, or habitat heterogeneity within a 600 m radius of the nest). Four habitat covariates were associated with higher fecundity, but collectively they were representative of areas having higher habitat heterogeneity. Harvesting or take of an owl site did not enter the survival model, but it did have a negative effect on fecundity. The effect of set-asides was complex with the highest survival and fecundity associated with areas near (< ½ mile) but not inside set-asides. Of the non-habitat variables, increased days of precipitation during the early nesting entered the top survival and fecundity models with a negative coefficient (Diller et al. 2010).

Relative to other categorical variables, HFP was most sensitive to the location of the nest site/activity center relative to a set-aside. HFP values were highest in the ½ mile buffer surrounding a set-aside with all other covariates being realistically equal. While considerably lower relative to the magnitude of the effect, take (i.e., harvesting an owl site) with a negative coefficient was the second most important categorical variable. Relative to continuous variables, the most important habitat variable was edge density, where increases in this variable resulted in higher values of habitat fitness. Of the non-habitat variables, HFP was most sensitive to changes in precipitation during the early nesting period such that increases in the total number of days of measurable precipitation within the early nesting period caused habitat fitness to decline (Diller et al. 2010). Despite the differences in the variables included in the analysis, possibly the most notable comparison is that landscapes with approximately equal amounts of older roosting/nesting habitat and other habitats provided the maximum HFP for both the Northwestern California/Willow Creek and Green Diamond study areas (Franklin et al. 2000, Diller et al. 2010).

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1133 **Table 4.** Comparison of three territory-based demographic studies in the interior of California and southern Oregon.

	Franklin et al. 2000	Diller et al. 2010	Olson et al. 2004	Dugger et al. 2005
Definition of older forest evaluated in the study (representing nesting/roosting habitat)	Spotted owl habitat = mature and old-growth forest with QMD of conifers >53 cm (~21 in), QMD of hardwoods >15 cm (~6 in), percentage of conifers >40%, and overstory canopy coverage >70%	Spotted owl habitat = mature second-growth >45 years and old-growth forests >180 years	Late-seral forest = stands characterized by trees with >80 cm (~31.5 in) dbh; generally associated with high quality nesting, roosting, and foraging habitat. Mid-seral forest = stands characterized by trees with 24-80 cm (9.5 - 31.5 in) dbh.	Old forest = older (>100 years) conifer or mixed stands characterized by canopy cover >40% and trees >35cm (~14 in) dbh. Old growth = old (>200 years) conifer-dominated stands characterized by canopy cover >40% and trees >75 cm (~29.5 in) dbh.
Relationship between older forest and survival	Positive Survival declined rapidly at sites with less than ~100 acres of spotted owl habitat in the core area (i.e. <25%) Core area = 390 acres	Positive Survival increased with older aged nest stands, but this was contingent on also having greater edge density within a 600 m radius of the nest	Positive In general, late-seral forest had a positive effect on survival. However, the best model showed highest survival when combined mid- and late-seral forest was about 70% of the 1,747 acre (1,500-m radius) circle	Positive Pseudothreshold relationship with survival rate dropping rapidly when proportion of old forest in the core drops below ~20-30% (~80-100 acres) Core area = ~413 acres
Relationship between older forest and productivity	Negative Nonlinear relationship with reproductive output increasing when amount of older forest in the core area is less than ~75-100 acres	Somewhat positive Older forest contributed to productivity but only if in a landscape with high habitat heterogeneity	Negative Productivity declined with increases in mid- and late-seral forest	Positive Linear effect with old growth forest in the core area providing the best model

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Amount of older forest in the core area for high fitness territories^a	Variable, with an apparent trade-off between providing sufficient older forest to support survival and provide a high amount of edge, while limiting portion of core area in older forest in order to support high productivity (see Fig 10 in Franklin et al. 2000; generally at least ~25% older forest required in core <u>with roughly 50%</u> to support high <u>est</u> fitness)	<u>Variable but with greatest fitness with roughly equal amounts of older and young forests.</u>	N/A The best model included only the 1,500m diameter circle (~1,747 acres representing broader home range)	In general, territories with <40% of the 413 acre core (~165 acres) composed of older forests had habitat fitness potential <1.0
Effect of habitat in broader home range or 'outer ring' on vital rates^b	N/A	<u>No effects on vital rates extended beyond 600m of the nest stand.</u>	Territories with high estimates for λ had a high amount of mid- and late-seral forest in the 1,747 acre area, but also have patches of nonforest within the mosaic of forest types	Survival declined when the amount of nonhabitat in the outer ring portion of the home range exceeded about 60%.
Relationship of vital rates with the amount of non-habitat (non-forest areas, sapling stands, etc.)	Did not evaluate <u>directly^c</u> but “other habitat” (which included <u>nonhabitats</u>) in juxtaposition with <u>late seral habitat created habitat heterogeneity that had a positive influence on habitat fitness</u>	<u>Early seral stands were important to create habitat heterogeneity that had a positive influence on habitat fitness</u>	Increases in early seral and nonforest had a negative effect on survival	Survival decreased dramatically when the amount of non-habitat exceeded ~50% of the home range
Relationship of vital rates with amount of edge between older forest and other vegetation types^d	Both apparent survival and reproductive output increased with increasing edge between spotted owl habitat and other vegetation types ^e	<u>Both apparent survival and reproductive output increased with increasing edge between spotted owl habitat and other vegetation types</u>	The best model showed a positive relationship between productivity and amount of edge between mid- and late- seral forest and the other types (early-seral and nonforest).	No support for either a positive or negative effect on survival or reproductive rate

^aSize of the core area evaluated varies across studies. Franklin et al. (2000) evaluated a 390 acre core area. Olson et al. (2004) evaluated a ~279 acre core area, but their best model included only the 1,500m diameter circle (~1,747 acres). Dugger et al. (2005) evaluated a ~413 acre core area.

^bSize of the broader home range or 'outer ring' evaluated varies across studies. Franklin et al. (2000) did not include an outer ring of habitat or broader home range in their modeling. Dugger et al. (2005) evaluated a ~3,455 acre outer ring. In addition to the core area, Olson et al. (2004) evaluated two larger circles of habitat of ~1,747 and ~4,473 acres.

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1139 | ^cFranklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types. While they were unable to quantify the relative
1140 | proportions of each, they indicated that "other habitats" were created naturally by fire, edaphic and topographic factors and through human-caused (logging) disturbance.
1141 | ^dEdge is defined differently among the studies. Franklin et al. (2000) defined edge as occurring between mature forest (spotted owl habitat) and all other vegetation types. Olson
1142 | et al. (2004) and Dugger et al. (2005) define edge as occurring between nonhabitat and all intermediate and mature forest types.
1143 | ^eFranklin et al. (2000) were unable to distinguish different types of edge, but suggested that edges between spotted owl habitat and clearcuts ~~do~~ did not generate the type of
1144 | mosaic that was observed in high-fitness territories.
1145

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In their Oregon coast study area, Olson et al. (2004) analyzed various forest types: late-seral, mid-seral (broken further into conifer and broadleaf), and non-forest, within 600, 1,500 and 2,400 m radius around Northern Spotted Owl site centers. The best model indicated survival was highest when the amount of mid- and late-seral forest was about 70% within the 1,500 m (0.9 mi) radius circle, and survival decreased when the amount of mid- and late-seral forest increased above about 85% or declined below about 50%. Increases in early seral or non-forest had a negative effect on survival. The best model indicated reproductive rates were positively correlated to the amount of edge between mid-seral and late-seral forest and other forest types (early-seral or non-forest), and suggested a high amount of mid- and late-seral forest in the 1,747 acre area with patches of nonforest within the mosaic of forest types provided high fitness.

In an Oregon study (including portions of the western Cascades and eastern Siskiyou Mountains, both comparable to areas in California), Dugger et al. (2005) found the best models contained a positive linear effect of older forest types in the core area (defined as 413 acres) on reproductive rate, with the best model including old-growth. There was strong evidence to support a positive relationship between amount of older forest types in the core area, and an increase in apparent survival. Dugger et al. (2005) found little to no effect on survival and reproduction rate for intermediate-aged forests, defined as forests between sapling and mature stages with total canopy cover over 40%. The study also analyzed habitat within a broader area around the core area, representing an outer ring of the home range (3,455 acres outside of the core area). Within the broader area, survival declined when the amount of non-habitat, defined as non-forest and early seral stages including sapling stage, within the ring outside the core area exceeded 60%. Survival estimates were highest when the amount of non-habitat fell between roughly 20 to 60% in the broader portion of the home range, and survival estimates were lower as non-habitat fell below 20% or above 60%. Modeling efforts did not find any direct effect of edge, although edge was defined differently than in the Franklin et al. (2000) study. Although Dugger et al. (2005) did not find any evidence that a mosaic of old forest intermixed with forests of intermediate age (with hardwood component) provided benefit to the Northern Spotted Owl, nor a benefit of edge, the negative quadratic relationship between owl survival and amount of non-habitat in the broader portion of the home range may suggest some benefit of an intermediate amount of “edge” in this larger area. The study concludes, “in general, territories with <40% old forest or old-growth habitat near the site center had habitat fitness potential <1, consistent with the relationships between both reproduction and survival and the amount of old forest habitat at the core.”

All ~~three~~ four of the above studies found a positive relationship between the amount of late-seral forest and survival, with two (Franklin et al. 2000, Dugger et al. 2005) showing a rapid decline in survival when the amount of late-seral forest in the core area dropped below about 25% (i.e., about 100 acres of late-seral forest is required in the 400 acre core to support survival). The third study (Olson et al. 2004) found that declines in survival accelerated when the amount of mid- and late-seral forest in a larger area (~1,750 acre) declined below 50%, with highest survival at 70% mid- and late-seral forest. Two of the ~~three~~ four studies found a negative relationship between the amount of older forest and productivity in the core area (Franklin et al. 2000) or in the broader home range (Olson et al. 2004); this shows an apparent trade-off between providing sufficient older forest to support survival, while limiting the

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amount of older forest to create high levels of habitat heterogeneity in order to support high productivity. The ~~third~~ study in the South Cascades of Oregon found a positive relationship between older forest in the core area and productivity (Dugger et al. 2005).

Dugger et al. (2005) found that territories required that about 40% of the core area be composed of older forests in order for HFP to be greater than 1.0. The results of Franklin et al. (2000) suggest that about 25% of the core area must be in older forest to support high fitness and both California studies found that HFP was maximized at owl sites with approximately equal amounts of nesting/roosting habitat and other habitats created by natural and human-caused disturbance as well as edaphic and topographic factors (Franklin et al. 2000, Diller et al. 2010). The two studies that evaluated a broader home range found that the amount of non-forested area and other forms of nonhabitat must be limited in order to support high HFP (Olson et al. 2004, Dugger et al. 2005). Olson et al. (2004) and Dugger et al. (2005) both found that survival decreased dramatically when the amount of early seral forest or other non-habitat exceeded ~50% of the home range.

In their coastal study area within California's Humboldt and Del Norte counties, Thome et al. (1999) showed that reproductive ~~rate~~ success was inversely related to age class and basal area age classes within forests managed with clear-cut silviculture practices. Specifically, sites with high proportions of 21-40 year-old stands, lower proportions of 61-80 year-old stands and the largest basal area class (>69 m²/ha) had higher reproduction ~~rate~~ success; however sites with higher reproduction ~~rate~~ success also had more residual trees at 50 hectare circle (0.149 trees/ha) and 114 hectare circle (0.201 trees/ha) surrounding owl sites. The explanation was presumed to be related to the larger abundance of preferred prey (i.e., woodrats) among younger forests coupled with the limited availability of older forests on the study area. The authors concluded that 21-40 year-old stands were young enough to contain sufficient amounts of prey during foraging, yet old enough to provide structural for roosting, nesting, and maneuverability, such as high canopy and large residual trees. This analysis was generally consistent with later analyses with additional data on the same study area that indicated the importance of habitat heterogeneity to support high HFP.

It is important to note that the relationships found between owl fitness and habitat in the studies described above apply only to areas with similar conditions as those analyzed as part of the studies, and findings may not be applicable to owl territories throughout the owl's entire range in California. For example, the study area described in Olson et al. (2005) comprised different forest types than those described in Dugger et al. (2005) or Franklin et al. (2000) and where the primary food source was flying squirrels rather than woodrats. Although they represented different forest types, the primary prey (dusky-footed woodrats) in the Franklin et al. (2000) and Diller et al. (2010) studies in California are similar and spotted owls have been documented to disperse between these two study areas (GDRC 2015). This would suggest that the results of these two studies probably have the greatest relevance for the majority of owl sites in California.

Overall, Northern Spotted Owls require some minimum level of old forest, including old-growth, within their core range and broader range to optimize survival and productivity. It is also apparent that older forest mixed with other forest types (excluding non-habitat) benefits Northern Spotted Owl fitness, at

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least partially due to the increased foraging opportunities along transitional edges. ~~This effect may be more prevalent in the interior zones of California and southern Oregon, (Klamath and Cascade provinces) where owl habitat differs significantly than coastal or more northern portions of the range.~~ In spite of uncertainties around which level of old forest and edge attains the best habitat fitness for owls, the literature points to the benefits of a mosaic of forest types that contain sufficient older forest, especially around the core area, while limiting the amount of nonhabitat in the home range. Based on the studies in the interior of the species' range in California and southern Oregon, management that maximizes late-seral forest in the core area (at least 25-40%) while limiting the amount of nonforest or sapling cover types throughout the home range (no more than about 50%) would likely result in high quality Spotted Owl territories.

Comment [A45]: 46. Note to external reviewers: Prior to final draft, we will consider adding Figure 6 from Dugger et al. (2005) or Figure 10 from Franklin et al. (2000) to illustrate the amounts and configuration of various habitat types in high quality territories.

Comment [LVD46]: 47. I strongly support adding Figure 10 from Franklin et al. (2000) given its obvious relevance to NSO in CA. Dugger et al. (2005) helps illustrate the variability of NSO ecology in different portions of its range, but presumably it doesn't have as much relevance for most NSO sites in CA.

Status and Trends in California

Abundance

No range-wide estimate for abundance of Northern Spotted Owl exists because survey methods and effort conducted to date do not provide for reliable estimation of population size across the range (USFWS 2011a). Few areas across the range have been sufficiently sampled to accurately estimate densities of Northern Spotted Owls (Franklin et al. 1990, Tanner and Gutiérrez 1995, Diller and Thome 1999). As mentioned above, Northern Spotted Owl densities vary across the range and forest types and so extrapolating the few local estimates across the range of the subspecies would result in biased estimates of abundance (See Life History section of this report for detailed information in density estimates in California). Because Northern Spotted Owls have large home ranges it is necessary to systematically survey very large areas in order to obtain reliable estimates of density (Franklin et al. 1990). Diller and Thome (1999) suggested that unless most individuals in a population are marked, density estimates would be biased. Studies that have provided density estimates have applied only to territorial owls (Diller and Thome 1999). Surveys do not effectively sample nonterritorial individuals (floaters); therefore, little is known about the floater population of owls other than they exist and that they generally do not respond to broadcast surveys. This leads to an issue of detectability that is difficult to overcome in estimating density or abundance of Northern Spotted Owls in a given area. Without an effective sampling method that addresses the ability to detect all owls in a given area, it is not possible to provide an accurate estimate of abundance. See the discussion on occupancy in the Demographic Rates section of this report for potential effects of floater owls on occupancy rates at known owl sites.

An early report out of the California Forestry Association (Taylor 1993) attempted to derive a population estimate for the Klamath Province in California. However, many assumptions were required in the analysis process, especially in developing estimates for amount of suitable habitat on federal and private land, estimating the fraction of land that had previously been surveyed, and estimating the proportion of sites that are occupied. In addition, no criteria were mentioned for what constituted "suitable" habitat, although 100% of forested land not owned by the USFS was considered to be suitable. The paper acknowledges that several of the assumptions made in deriving the population estimate are untested and that high levels of uncertainty exist in many of the estimates. Taylor (1993) partitioned

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land into ownership type, estimated the amount of suitable habitat on each type, estimated the fraction of land surveyed on each type, used the number of activity centers in the Department database and the estimates for fraction of suitable habitat surveyed to obtain an estimate of total sites in each type, and used an average occupancy rate from a subset of sites to extrapolate occupancy across the entire province. Estimates for suitable habitat and the percentages of suitable land surveyed for owls were derived from telephone interviews with landowners, timber company GIS layers and Timber Harvest Plan (THP) data, and a U.S. Forest Service report for National Forests. Due to the many untested assumptions and high amount of uncertainty in estimates, and the vague description of methods used, the report cannot be considered to provide a valid population estimate for the Klamath Province.

A recent study modeling exercise made use of the immense amount of data available on Northern Spotted Owl habitat requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity, dispersal behavior, and impacts of Barred Owl on spotted owl survival (but not other potential impacts including loss of habitat through interspecific competition), to model source-sink dynamics across the range of the owl (Schumaker et al. 2014). In addition to an evaluation of source-sink dynamics, outcomes of the model simulation included a range-wide projections of potential population size estimate, and the proportion of the simulated population in each modeling region and physiographic province noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). The simulated projections of owl abundance were created by first populating the modeled owl “universe” with 10,000 female spotted owls then running model simulations until a range-wide steady state was reached using a static habitat map. Based on projections from this model, Estimates of regional population sizes indicate that Northern Spotted Owls are have the potential to be most abundant in parts of southern Oregon and northern California (Table 5). The three California provinces were estimated to projected to have the potential to contain support over 50 percent of the range-wide Northern Spotted Owl population. The model indicated that the Klamath region is has the potential to be a stronghold for the population, with the Oregon Klamath and California Klamath provinces having the potential to cumulatively support 50.1 percent cumulatively within the Oregon Klamath and California Klamath provinces, and 37.1 percent within the Klamath East and Klamath West modeling regions. Model simulations indicated that habitat range-wide has the potential to support Schumaker et al. (2014) an estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions (Schumaker et al. 2014). Although informed by the best available data to develop an impressive assessment of source-sink dynamics across the range, the complexity of the model, the inability to fully integrate the full potential Barred Owl impacts and the fact that it was based on a static habitat map may limit its ability to accurately model-simulate population estimates potential. For example, differences in the simulated number of owls versus the numbers observed-estimated in eight demographic study areas used for calibration ranged from 5 to 47 percent (Schumaker et al. 2014). Nevertheless, the results suggest that California’s population of Northern Spotted Owls is has the potential to be an important component of the range-wide population.

Comment [LVD47]: 48. I think this is misleading concerning the modeling exercise described by Schumaker et al. (2014). This was not an actual estimate of the NSO population, but the output of a model simulations. The population size was produced through modeling simulations in which 10,000 females were initially “placed” into a modeling grid in the best habitats throughout the landscape. The estimates of NSO abundance were a model output from the results gathered following 10 replicates of 1,000 time steps. The population size for each region was purely hypothetical and a function of the model inputs related to owl habitat (generated from literature review and expert opinion), projected barred owl impacts on survival, modeled movements of NSO throughout a projected landscape matrix and etc. As stated by the authors: “We make use of a detailed NSO model here, but do so for the purpose of introducing new methodology—our intent is not to design, improve, or promote NSO management strategies.”

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Table 5. Percent of range-wide Northern Spotted Owl population within modeling region and physiographic province (adapted from Table 2 in Schumaker et al. 2014).

Modeling Region	Percent of Population	Physiographic Province	Percent of Population
North Coast Olympics	0.1	Washington Western Cascades	1.3
West Cascades North	0.1	Washington Eastern Cascades	1.6
East Cascades North	3.3	Washington Olympic Peninsula	>0.0
West Cascades Central	1.2	Washington Western Lowland	>0.0
Oregon Coast	1.0	Oregon Eastern Cascades	3.5
West Cascades South	15.3	Oregon Western Cascades	23.3
Klamath West	20.0	Oregon Coast	0.8
Klamath East	17.1	Oregon Willamette Valley	>0.0
Redwood Coast	16.4	Oregon Klamath	13.7
East Cascade South	3.8	California Coast	16.6
Inner California Coast	21.7	California Cascades	2.8
		California Klamath	36.4

Comment [LVD48]: 49.I think all of this table should be deleted since it is the product of a model simulation and does not represent an attempt to estimate the actual NSO population.

Most surveys for Northern Spotted Owls have been conducted on areas proposed for timber management activities in order to assess the potential for impacting the species, or on demographic study areas throughout the subspecies range. Although not designed for estimating density or abundance, pre-harvest surveys have dramatically increased knowledge on location of territorial owl sites (i.e., activity centers). As survey effort has expanded to new areas over time, the number of known activity centers has naturally increased. Although owls will shift activity centers over time, they exhibit high site fidelity to general nesting and roosting areas (Gutiérrez et al. 1995, Blakesley et al. 2006), therefore the increase in number of activity centers over time is more likely a result of expanded survey effort than establishment of new activity centers. In addition, across most of the Northern Spotted Owl range establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a slow process given tree species growth rate, and so a rapid increase in the number of activity centers due to colonization of new habitat is unlikely. The possible exception to this is on the redwood coast where Northern Spotted Owls have been shown to commonly select relatively young forests (41-60 years old, with recent nests being documented in 30-35 year old third growth stands, L. Diller, pers. comm.) for nesting and roosting, as long as all habitat requirements are present (Thome et al. 1999, Diller et al. 2010). For example, Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature (GDRC 2015). However, this does not indicate a net increase in owl sites across the ownership, because other sites have been lost due to timber management and the influence of barred owls. But it does illustrate the highly dynamic nature of spotted owl habitat on a managed landscape in the redwood region and the potential for owl sites to increase if the negative Barred Owl influence is mitigated.

Comment [LVD49]: 50.This does not indicate a net increase in NSO sites, because other sites were lost as new sites were found. This just illustrates the highly dynamic nature of NSO sites on a managed landscape in the redwood region. There is sufficient habitat for the number of owl sites to increase, but unless the barred owl influence is mitigated, the NSO population is not going to be able to make use of all the potential habitat.

The number of newly established activity centers across the range as a result of newly available nesting and roosting habitat is unknown. See the discussion on habitat changes in the threats section for additional information on the topic of habitat recruitment. The Humboldt Redwood Company has also reported an increase in number of sites since 2008 (HRC 2015). A concurrent increase in detections of

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1331 Barred Owls in heavily surveyed areas suggests that the increase in Spotted Owl activity centers is likely
1332 due at least in part to increased survey effort (see Figure 28 in the Threats section of this report).
1333 However, it is possible that the increase in Spotted Owl activity centers is due to the movement of
1334 Spotted Owls as a result of displacement by an increasing number of Barred Owls (HRC 2015) or
1335 displacement from lands that are no longer suitable due to timber harvest or wildfire.

1336 In California, the number of known Northern Spotted Owl activity centers rapidly increased starting
1337 around 1990 when listing under the federal Endangered Species Act resulted in a widespread increase in
1338 survey effort (Figure 3). Through 1989, there were 1,366 Northern Spotted Owl activity centers in
1339 California. By the year 1999, this number had increased to 2,799. As of 2014, the number of Northern
1340 Spotted Owl activity centers was 3,116. The number of occupied activity centers in any given year is
1341 unknown because not all areas have been or can be surveyed on an annual basis (USFWS 2011a). It is
1342 likely that many of the known sites are unoccupied because of habitat loss due to timber harvest or
1343 severe fires, displacement by Barred Owls, or other factors, therefore much of the data from early
1344 survey reports are outdated and of little use in addressing population abundance or distribution
1345 questions (Courtney et al. 2004). For these reasons and for the sampling reasons discussed above, the
1346 number of activity centers does not represent an index of abundance but rather the cumulative number
1347 of territories recorded (USFWS 2011a).

1348 Demographic Rates

1349 “Because the existing survey coverage and effort are insufficient to produce reliable range-wide
1350 estimates of population size, demographic data are used to evaluate trends in Spotted Owl populations”
1351 – USFWS (2011a).

1352 The U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) initiated eight long-term
1353 demography studies within the range of the Northern Spotted Owl during the years 1985 to 1991 in
1354 order to provide data on the status and trends of Spotted Owl populations, and to inform the
1355 effectiveness of the NWFP on federal lands (Lint et al. 1999). Additional demographic study areas that
1356 were not established under the NWFP have also been initiated. The additional study areas that are
1357 currently active include one initiated in 1990 entirely on private land (i.e., Green Diamond Resource
1358 Company), one initiated in 1992 on the Hoopa Indian Reservation land, and one composed of a mix of
1359 federal, private, and state lands initiated in 1992 (i.e., Rainer). The study areas range between
1360 Washington and northern California, and collectively represent about 9% of the range of the Northern
1361 Spotted Owl (Forsman et al. 2014; Dugger et al. In press; Figure 71).

1362 Periodically, the principal investigators, field biologists and a team of renowned analyst gather to
1363 individually and collectively analyze their data in what is termed the Northern Spotted Owl meta-
1364 analysis (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006,
1365 Forsman et al. 2011, Dugger et al. In press). These eleven study areas included in the most recent meta-
1366 analysis have had been monitored annually since inception with an average of 19-24 survey years across
1367 all areas (Table 62) following the 2013 field season on which the Dugger et al (In press) publication was
1368 based. On each study area, territorial owls are captured and banded, followed by annual attempts to

Comment [LVD50]: 51. It makes sense that barred owls could create an apparent increase in owl sites by causing individual NSO to move around and be “double counted.” However, that shouldn’t happen if the birds are banded and I think HRC is banding their owls. It doesn’t make sense that you could get an apparent increase in owl sites due to displacement from timber harvest or wildfire, because the original sites would be lost with no net gain. The only way it would be possible is if a site wiped out by timber harvest or wildfire was still counted as an occupied site and I don’t know anyone that would consider that an appropriate way to tally owl sites.

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recapture or resight owls and to evaluate reproductive success of territorial pairs. Standard protocols ensure consistent and thorough attempts to band and resight territorial owls and to assess nesting status of territorial females (Anthony et al. 2006). Over the period of 17-24 years (depending on study area), a total of 5,224 non-juvenile owls had~~ve~~ been marked in the eleven study areas with a total of 24,408 annual captures/recaptures/resightings, allowing for robust estimates of survival. The number of young produced by territorial females was determined in 11,450 separate cases (Forsman et al. 2011). Three study areas are located in California, representing a diverse land ownership; the Northwest California study area (NWC) is primarily on federal land, the Green Diamond Resource Company study area (GDR) is on private land, and the Hoopa Indian Reservation study area (HUP) is on tribal land. These three study areas cover approximately 6% of the range of the Northern Spotted Owl in California (based on the USFWS range). The GDR study area is entirely within the California Coast Province, the HUP study area is located on the western edge of the California Klamath Province, and the NWC study area is mostly in the Klamath Province with a small portion in the Coast Province. There is no demographic study area in the California Cascades Province.

Table 6. Descriptions of 11 demographic study areas used to assess vital rates and population trends through 2008. Adapted from Table 1 and Appendix A in Forsman et al. (2011).

Study Area	Acronym	Years	Area (km ²)	Ownership
<i>Washington</i>				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
<i>Oregon</i>				
Coast Ranges*	COA	1990-2008	3,922	Mixed
H.J. Andrews*	HJA	1988-2008	1,604	Federal
Tyee*	TYE	1990-2008	1,026	Mixed
Klamath*	KLA	1990-2008	1,422	Mixed
South Cascades*	CAS	1991-2008	3,377	Federal
<i>California</i>				
NW California*	NWC	1985-2008	460	Federal
Hoopa Tribe	HUP	1992-2008	356	Tribal
Green Diamond	GDR	1990-2008	1,465	Private

*Indicates the eight study areas that are part of the federal monitoring program for the northern spotted owl.

(Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011). Data from the demographic study areas have been compiled and analyzed regularly, with the most recent analysis covering all survey years through 2008

Although the study areas were not randomly selected and only represent a small fraction of the Northern Spotted Owl's range, the meta-analysis provides the best statistically rigorous analysis of status and trends of the owl's population within its range. -Demographic rates are estimated for each study area, and for all study areas combined (meta-analysis). ~~An additional~~The most recent meta-analysis of data from the demographic study areas ~~is has been accepted for publication~~ongoing_ and will

Comment [LVD51]: 52. Replace with results from Dugger et al. In press.

Comment [LVD52]: 53. Replace with results from Dugger et al. In press.

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1394 include data through 2013 (Dugger et al. *In press*). This additional information should provide further
1395 insight into important demographic rates across the species range. As discussed above, data collected
1396 from existing surveys are not sufficient to estimate population sizes, and so population trends cannot be
1397 assessed by comparing estimates of population size over time. However, the consistent collection of
1398 large amounts of capture/recapture data and observations of reproductive effort has resulted in an
1399 enormous amount of information which allows for estimation of vital rates across much of the range of
1400 the Northern Spotted Owl. When sufficient data ~~is are~~ available, examination of demographic trends in
1401 survival and reproduction is one of the most reliable methods of assessing the health of a population.
1402 These data also allow for estimation of the annual rate of population change, λ , which reflects
1403 changes in population size resulting from reproduction, mortality, and movement into and out of a study
1404 area. λ does not provide a numerical estimate of population size, but instead estimates the
1405 proportional change in a population over ~~a set period of time~~.

1406 In addition to the coordinated analysis of data from all demographic study areas that occurs every 5
1407 years, reports are available from individual study areas. Results from these reports are included in the
1408 discussion below when they offer more current information on the three California study areas than the
1409 most recent coordinated meta-analysis of 2011.

1410 *Rate of Population Change*

1411 A primary goal of the large scale monitoring at the demographic study areas and the regular coordinated
1412 analysis of data is to monitor population trends of the Northern Spotted Owl through estimation of
1413 λ (λ , defined as annual finite rate of population change) (Anthony et al. 2006, Forsman et al.
1414 2011). A λ of 1.0 indicates that a population is stationary, whereas values greater or less than 1.0
1415 indicate increasing or declining populations, respectively. The most recent meta-analysis for all eleven
1416 study areas produced a weighted mean λ of 0.971 (standard error = 0.007, 95% confidence interval =
1417 0.960 to 0.983), corresponding to an average rate of population decline of 2.9% per year from 1985 to
1418 2006 (Forsman et al. 2011). Estimates of λ were below 1.0 for all 11 individual study areas, and ranged
1419 from 0.929 to 0.996 (Table 7). Population declines were most pronounced in Washington and the Coast
1420 Ranges of Oregon. The 95% confidence intervals do not overlap 1.0 for seven of the study areas,
1421 indicating strong evidence for population decline on these seven study areas. Although this study area-
1422 level demographic analysis did not show evidence for declines at KLA and CAS study areas, a territory-
1423 based study conducted in the Klamath Mountains and Cascade Range of southwest Oregon showed
1424 evidence for declining populations by 1996 (Dugger et al. 2005). In California, populations at GDR and
1425 NWC have declined, with estimates of λ of 0.972 for GDR (2.8% decline per year) and 0.983 for NWC
1426 (1.7% decline per year).

1427 In a more recent analysis of the available data, Franklin et al. (2015) reported a λ of 0.976 (1985-2013;
1428 95% CI 0.953-0.998) for the Willow Creek Study Area (part of the NWC study area). This shows an
1429 accelerated rate of decline (2.4% decline per year) compared to that reported by Forsman et al. (2011)
1430 for NWC. As reported in Forsman et al. (2011), the 95% confidence interval for HUP overlapped 1.0, so
1431 the study could not conclude that this population was declining through 2008. However, Higley and

Comment [A53]: 54. Note to external reviewers:

55. Where more recent data on demographic rates are available, either through annual reports or through presentations that have been publicly available, we include results as appropriate. We will update this report to include full results of the ongoing meta-analysis if the full publication becomes available prior to finalizing this status review.

Comment [LVD54]: 56. All of the following needs to be updated with Dugger et al. *In press*.

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1432 Mendia (2013) reported a λ of 0.977 (1985-2012; SE = 0.01; 95% CI 0.958-0.996) equating to a 2.3%
1433 population decline per year through 2012. This is the first time that the 95% CI for HUP does not include
1434 1.0, providing strong evidence that all three study areas in California now have declining populations of
1435 owls.

1436

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Table 7. Demographic parameters for the Northern Spotted Owl demographic study areas through the year 2008. Adapted from Table 22 in Forsman et al. (2011) and Table A-1 in USFWS (2011).

Study Area	Fecundity	Apparent Survival ¹	Lambda (λ)	Population Change ²
<i>Washington</i>				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
<i>Oregon</i>				
Coast Ranges	Increasing	Declining	0.966	Declining
H.J. Andrews	Increasing	Declining	0.977	Declining
Tyee	Stable	Declining	0.996	Stationary
Klamath	Declining	Stable	0.990	Stationary
South Cascades	Declining	Declining	0.982	Stationary
<i>California</i>				
NW California	Declining	Declining	0.983	Declining
Hoopa	Stable	Declining	0.989	Stationary
Green Diamond	Declining	Declining	0.972	Declining

¹ Apparent survival calculations are based on model average.

² Population trends are based on estimates of realized population change.

Comment [LVD55]: 57.Update with Dugger et al.

Conversion of estimates for λ to estimates of realized population change (i.e., the proportional change in estimated population size relative to population size in the initial year of analysis) revealed dramatic declines in regional population sizes (Forsman et al. 2011). The study areas in the northern portion of the range showed precipitous declines, with populations in the Olympic, Cle Elum, and Rainier study areas in Washington and the Coast Range study area in Oregon estimated to have declined by 40 to 60% during the study period (Forsman et al. 2011). At a rate of decline of 2.9% per year, the total population of Northern Spotted Owls across all study areas would have declined by nearly 50% over the 22 years included in the study. Although the 95% confidence intervals for estimates of realized population change slightly overlapped zero, two study areas in California (NWC and GDR) showed estimated population declines of about 20% during the period of study. Using the revised estimate of λ for NWC through year 2013 (Franklin et al. 2015) would result in a larger estimated population decline for NWC. The other study area in California (HUP), showed a slight decline in population size at the end of the study period in 2008, but the 95% confidence interval broadly overlapped zero. Again, using more recent data such as those reported by Higley and Mendia (2013) would provide stronger evidence for a population decline at HUP.

Comment [LVD56]: 58.Replace with results from Dugger et al. In press.

Although the meta-analysis assessing vital rates on all demographic study areas through 2013 is ongoing, preliminary meetings held to coordinate data compilation and analyses indicate that the decline in Northern Spotted Owl populations across the range ~~is ongoing~~has continued and accelerated; the average rate of population decline per year on the eleven demographic study areas has been 3.8% per year (Dugger et al. in review, Higley and Mendia 2013), compared to a decline of

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2.9% per year using data through 2008 (Forsman et al. 2011). The ongoing analysis has revealed large changes becoming apparent in Oregon and California, with Northern Spotted Owl populations in California declining by 32-55% over the study period (1985-2013; Dugger et al. in review).

Fecundity and Survival

Fecundity (i.e., number of female young produced per adult female) and survival rates are estimated in order to inform estimates of λ , to determine the degree to which changes in these vital rates effect populations, and to model effect of potential explanatory variables on these important vital rates. The Northern Spotted Owl is a long-lived species, with relatively high adult survival rates, and with high variability in fecundity from year to year. Fecundity estimates varied across study areas and ranged from 0.230 to 0.553 female young produced per adult female (Forsman et al. 2011). Most Spotted Owls do not breed every year, but more normally breed every other year, which contributes to low fecundity in the species. There was evidence for declining fecundity on five areas, three areas were stable, and three areas showed increasing fecundity (Forsman et al. 2011). In California, fecundity showed declines on two areas (NWC and GDR) and was stable on one area (HUP), although HUP exhibited the lowest fecundity rate of all eleven study areas. Apparent Adult survival (i.e., termed “apparent” because mortality and permanent emigration cannot be separated) has declined on 10 of 11 study areas, with the Klamath study area in Oregon being the exception. Annual survival rate represents the probability that a bird that was alive in one year will be alive the following year, therefore a mean rate of 1.0 would indicate that all birds survive from one year to the next. Values of mean apparent adult survival for the entire study period range from 0.819 to 0.865, with declines most pronounced in Washington and Oregon. Apparent survival rates in Washington had been less than 80 percent in years leading up to 2008, a rate that is unlikely to allow for sustainable populations (Forsman et al. 2011). Although less severe than in Washington and much of Oregon, all California study areas show declines in survival (Table 7).

For most demographic study areas, changes in λ were driven mainly by changes in survival. This is consistent with the hypothetical-hypothesized expectation from a long-lived species with high variability in fecundity over time, and is also consistent with previous studies showing that annual rates of population change are most influenced by changes in adult survival (Noon and Biles 1990, Lande 1991, Blakesley et al. 2001). This is a concerning finding because apparent survival was shown to be declining on 10 of 11 study areas across the entire range of the subspecies, including all three California study areas. In the previous demographic analysis analyzing data from 1985-2003 (Anthony et al. 2006), declines in adult survival in Oregon had not been observed and only one study area in California showed declines, therefore declines in survival in the southern portion of the range occurred predominantly in the most recent five years for which data were available (2004-2008). The overall assessment from the most recent demographic study (Forsman et al. 2011) is that reproduction and recruitment have not been sufficient to balance losses due to mortality and emigration, so many of the populations on study areas have declined over the two decades included in the study.

Comment [LVD57]: 59. Same issue of updating this entire section with Dugger et al.

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When the NWFP was implemented, it was assumed that Northern Spotted Owl populations would continue to decline for up to a few decades, but would gradually increase and eventually stabilize as habitat protection and successional processes increased available habitat on reserve lands (USDA and USDI 1994). To date, five meta-analyses have been conducted on data from Northern Spotted Owl demographic study areas, with results readily available for three of the analyses. As noted above, a sixth meta-analysis is ongoing has been completed and will include all survey years data collected through the 2013 field season. In the second meta-analysis, which summarized results through 1993 (Burnham et al. 1996), no trend in fecundity was detected and survival was shown to be declining among adult female owls; λ was less than 1.0 for most study areas. The fourth meta-analysis which covered data through 2003 (Anthony et al. 2006) found evidence for declining fecundity at six study areas (although 95% confidence intervals overlapped zero for all six areas), and strong evidence that survival was declining on four of 14 study areas included in the analysis (two of which no longer participate in the demographic analysis). Mean λ across all study areas was also less than 1.0 with an annual rate of population decline estimated to be 3.7%, although only four study areas had 95% confidence intervals for estimates of λ that did not overlap 1.0 (Anthony et al. 2006). The fifth and most recent available meta-analysis covers data through 2008 (Forsman et al. 2011) and provides strong evidence for a decline in fecundity on 5 of 11 study areas and strong evidence for declining survival on 10 of 11 study areas. After two decades of NWFP implementation, it is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of demographic rates indicate that across much of the range, the decline has accelerated. This is evident in the declining populations on seven of the 11 study areas, only two of which showed strong evidence for decline in the previous analysis.

In California, two of three study areas (NWC and GDR) in the recent analysis were shown to be experiencing declines in fecundity and all California study areas showed declines in survival (Forsman et al. 2011). The previous analysis also found evidence of declining fecundity on two California study areas but found evidence for declining survival on only one (Anthony et al. 2006). Although estimates of λ for study areas in California are not as low as those in Washington and northern Oregon, negative trends in vital rates had led to population declines on at least two of three California study areas by 2008 (NWC and GDR). The decline at the NWC study areas had apparently not begun by 1994 (Franklin et al. 2000). Although Northern Spotted Owls at the southern portion of the range appear to have been temporally buffered from population declines, the ongoing and accelerating decline in demographic rates had effected populations in California by 2008.

Most of the demographic study areas were established to evaluate the effectiveness of the NWFP and consist of federal lands or a mix of federal and nonfederal lands. Although not randomly chosen, Forsman et al. (2011) suggests that results from the demographic study areas are representative of federal lands and areas of mixed federal and private lands throughout the range of the Northern Spotted Owl because “the study areas were (1) large, covering about 9% of the range of the subspecies; (2) distributed across a broad geographic region and within most of the geographic provinces occupied by the owl; and (3) the percent cover of owl habitat was similar between our study areas and the surrounding landscapes”. The authors expressed less confidence that study areas reflected trends on non-federal lands because the two study areas consisting mainly of non-federal lands (GDR and HUP)

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are near the southern edge of the subspecies' range and both are actively managed for Spotted Owl habitat. These two non-federal study areas might not accurately represent other non-federal lands in California because of the management mentioned above and because they are located in the California Coast and western edge of the California Klamath physiographic provinces, and may not accurately represent conditions in other parts of the California range, especially the California Cascades. The authors suggested that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands (Forsman et al. 2011).

Although results from the ongoing meta-analysis for the eleven demographic study areas are not yet available, recent reports from individual study areas in California (NWC, HUP, and GDR) provide information on current estimates for reproductive success and survival. At GDR, reproductive success (number of young fledged per monitored site) showed a negative trend from 1992-2014 (regression slope = -0.014), with a mean of 0.54 during this time period (GDRC 2015). This is a different metric of fecundity than used in the most recent demographic analysis (Forsman et al. 2011; number of female young produced per adult female), but shows a continuing decline in productivity since 2008. On HUP, mean reproductive rate (young fledged per monitored female; also a different measure of fecundity) from 1991-2013 was 0.42 with a range of 0.05 to 1.04 (Higley and Mendia 2013). During 2011, 2012 and 2013 HUP showed unusually low reproductive rates of 0.05, 0.13, and 0.06, respectively. In 2013, adult survival was approximately 0.8 on HUP (Higley and Mendia 2013), which is lower than that reported by Forsman et al. (2011). Annual apparent survival for territories surveyed on NWC averaged 0.848 for 1985-2014 (Franklin et al. 2015). Reproductive rate has also been reported for private timberlands outside of the demographic study areas, although monitoring and analysis approaches are not standardized as in the eleven demographic study areas, so direct comparisons are not possible. Humboldt Redwood Company reported a reproductive rate (number of young per pair) of 0.49 in 2014 (HRC 2015) and Mendocino Redwood Company reported a reproductive rate of approximately 0.12 in 2014 (MRC 2014). HRC (2013) noted a drop in reproductive rate since 2009. These more recent estimates of reproductive rate and survival since the last demographic meta-analysis (Forsman et al. 2011) are consistent with a continued decline within the demographic study areas in California.

As mentioned in the Life History section, most Spotted Owls do not breed every year and historically annual variation in reproductive effort and success is thought to be related to local weather conditions and fluctuations in prey abundance. This results in most areas having high variation in reproductive success between good years and bad years and can be seen in modeled rates of fecundity (Forsman et al. 2011). In the coastal portion of the Northern Spotted Owl range in California, many areas reported consistently low reproductive success from 2011-2013, including some of the lowest reproductive success rates on record in 2013. This is despite weather conditions in 2013 that would typically support good reproductive success. This was observed on many timber company lands (Calforests 2014, HRC 2014, GDRC 2015), tribal lands (Higley and Mendia 2013), and National Park land (Ellis et al. 2013). Furthermore, Douglas (2015) reviewed empirical survey data from 10 commercial timberland owners in northern California and noted that after 2008 there was an "unprecedented decline in spotted owl reproduction on coastal ownerships", which also coincided with an increase in Barred Owl detections.

Comment [LVD58]: 60.Presentation given to the Western Section TWS barred owl symposium with the abstract published on the WSTWS website.

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1578 | While the decline in reproduction coincided with the first major increase in Barred Owls in many areas
1579 | of coastal California, the reason for this widespread pattern of low reproductive success is not known.

1580 | In addition to providing rigorous estimates of survival, productivity, and population change across much
1581 | of the range of the Northern Spotted Owl, the large amount of data and the regular demographic
1582 | analyses allow for investigation of potential associations between population parameters and covariates
1583 | that might explain estimates and trends (Forsman et al. 2011). Potential explanatory variables included
1584 | in modeling during the most recent analysis of fecundity, survival, and λ included multiple weather and
1585 | climate covariates, a habitat covariate, a Barred Owl covariate, and several other broad geographic
1586 | covariates. Unlike studies that have modeled vital rates and potential explanatory variables at the scale
1587 | of individual owl territories (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Diller et al. 2010),
1588 | the meta-analysis evaluates covariates as an average effect across large study areas. The Barred Owl
1589 | covariate was evaluated as the proportion of Northern Spotted Owl territories in each study area that
1590 | had Barred Owls detected within a 1-km (0.62 mi) radius of activity centers. The habitat variable was the
1591 | proportion of “suitable habitat” (based on Davis and Lint (2005), but generally characterized as
1592 | containing large overstory conifers (dbh > 50cm) and canopy closure >70% in the study area). Although
1593 | modeling average effect across large study areas is not as powerful at detecting effects that are
1594 | influential at the territory scale (e.g., presence of Barred Owl or habitat conditions), data limitations
1595 | required a coarser evaluation at the broad scale of the demographic analysis in order for methods to be
1596 | consistently applied across study areas (Forsman et al. 2011). The broad demographic analysis found
1597 | relatively weak associations between the amount of habitat and demographic rates, and somewhat
1598 | larger effects of Barred Owl. These results, and those from more powerful territory-based studies, are
1599 | discussed in the Habitat Requirements section and in the Threats section of this report.

Comment [LVD59]: 61. Replace with results from Dugger et al. In press.

1600 | Occupancy

1601 | Occupancy data are less resource-intensive to collect compared to data required to estimate the
1602 | demographic parameters discussed above. Estimation of survival and reproduction requires the
1603 | capturing and banding of owls at known sites, and multiple annual visits to all sites in order to recapture
1604 | or re-sight owls, and to determine reproductive status. Occupancy data is based on the presence or
1605 | absence of owls from known sites, and depending on the objectives of the monitoring does not
1606 | necessarily require the monitoring of all sites each year. Due to this reduced requirement in survey
1607 | effort and the necessity to visit known owl sites during pre-timber harvest monitoring, this type of data
1608 | has frequently been collected and reported by timber companies and by other landowners (e.g. National
1609 | Parks).

Comment [A60]: 62. Note to external reviewers: The ongoing demographic analysis covering all survey years through 2013 will include occupancy modeling for the first time. Though we have included some preliminary results in this report when available (cited as “Dugger et al. in review”), we will update prior to finalizing if the full publication becomes available.

1610 | Although occupancy might appear to provide a substitute for estimates of survival, reproduction, or the
1611 | rate of population change, it is not always appropriate to use an apparently stable occupancy rate to
1612 | suggest a stable population size. As explained by Forsman et al. (1996),

1613 | “...it is possible that in a declining population, observed densities of territorial owls might not
1614 | change during early years of the decline simply because territorial owls that died could be
1615 | replaced by floaters (owls without territories) (Franklin 1992). Thus, significant changes in

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1616 density of territorial owls might not become apparent for many years, especially if the rate of
1617 population decline was small (e.g., 1-2% per year).”

1618 Therefore, a lack of a significant decline in observed owl numbers cannot necessarily confirm or refute
1619 estimates of survival or λ . Although little is known about the floater population of Northern Spotted
1620 Owls at any study area, other than that they exist and that they do not readily reply to broadcast calling,
1621 the number of floaters is finite. The perception of population stability due to establishment of territories
1622 by floaters cannot continue indefinitely in a constantly shrinking population. Depending on the rate of
1623 population decline (λ), the phenomenon should gradually disappear as the floater population is
1624 depleted. If a study area has a relatively robust population of floaters, or if emigration into the study
1625 area occurs, the local population can decline for some time before being detected through declines in
1626 occupancy. Although declines in occupancy can indicate a reduction in local abundance when survey
1627 efforts are consistent over time (Bigley and Franklin 2004), a stable occupancy rate may not necessarily
1628 indicate that a population is stable.

1629 Higley and Mendia (2013) observed inflated rates of occupancy on the Hoopa Valley Indian Reservation,
1630 and suggested that if owls are not color banded, it may be difficult to interpret stable occupancy rates.
1631 The authors believe that inflation of observed occupancy rates may be more likely in areas where Barred
1632 Owls are present and displace Spotted Owls:

1633 “Furthermore, because our owls are color banded, we know that they are being observed in
1634 more than one territory per season... They are moving vast distances (several miles). Due to this
1635 movement, we may be seeing an inflated occupancy (use) rate on the landscape that is well
1636 above the actual rate. If this behavior exists in study areas without color-banded owls, there
1637 would be no way to determine whether owls in multiple sites were in fact the same individual.”

1638 Although an evaluation of occupancy rates has not been included in previous demographic analyses, the
1639 authors of the most recently completed analysis note that the number of territorial owls detected on all
1640 11 areas was lower at the end of the study period than at the beginning, and few territorial owls could
1641 be found on some of the study areas in 2008 (Forsman et al. 2011). This is an important consideration in
1642 interpreting results of the demographic analysis because estimates of fecundity and survival rates are
1643 independent of population size. The estimated rates are averages for all owls in a study area and so do
1644 not incorporate any measure of population size. If a study area experiences a declining number of
1645 territorial owls, which on average are experiencing reductions in rates of fecundity, the result will be far
1646 fewer owls produced each year. Even if Northern Spotted Owls at a given study area experience stable
1647 rates of fecundity over time, areas with declining occupancy rates will produce fewer young overall. This
1648 phenomenon might also explain the relatively weak effect of Barred Owls on fecundity at some study
1649 areas (see discussion of Barred Owl in Threats section). If Northern Spotted Owls become displaced by
1650 Barred Owls, they are less likely to be detected (either because of increased mortality or because they
1651 are non-territorial and non-responsive to calls). Any Northern Spotted Owls not displaced may continue
1652 to breed at historical levels, resulting in no detectable reduction in fecundity on average, or they may
1653 breed at some unknown level in sub-prime habitat and remain undetected. However, the net effect is
1654 that fewer Northern Spotted Owls are produced (Forsman et al. 2011).

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1655 In order for estimates of occupancy to be valid, ~~survey efforts must be consistent over time and the~~
1656 ~~detection probability (the probability of detecting an owl if one is present) must be estimated.~~
1657 ~~inconsistent survey effort can lead to high variation in detection probability which can skew estimates of~~
1658 ~~occupancy if not accounted for.~~ Ideally the owl population would also be banded in order to address the
1659 concern of inflated occupancy rates observed by Higley and Mendia (2013), at ~~least in areas where~~
1660 ~~Barred Owls are~~ present. The ~~ongoing-most recent~~ demographic analysis using data from the eleven
1661 demographic study areas and covering all survey years through 2013 ~~will~~ include occupancy modeling
1662 for the first time. Preliminary ~~r~~Results ~~show indicate~~ that occupancy rates have declined at all three
1663 California study areas, with 32-37% declines from 1995-2013 (Dugger et al. in ~~review~~press). All
1664 demographic study areas in Washington and Oregon have also experienced declines in occupancy,
1665 which is consistent with previous reports from these areas (Olson et al. 2005, Kroll et al. 2010, Dugger et
1666 al. 2011, Davis et al. 2013). Occupancy rates in Washington have declined by as much as 74% (Dugger et
1667 al. in ~~review~~press). Occupancy rates are a balance between rates of local territory extinction and rate of
1668 colonization. Barred Owls were shown to have a strong effect on occupancy by increasing the local
1669 territory extinction rate (Dugger et al. in ~~review~~press). There is also some evidence of that Northern
1670 Spotted Owl will not reoccupy empty sites if Barred Owls are present. Preliminary results also show a
1671 positive effect of habitat on colonization rates, and a negative effect of habitat in the core area on
1672 extinction rates (i.e. less habitat in the core area leads to higher extinction rate) (Dugger et al. in
1673 ~~review~~press).

1674 Outside of the three California demographic study areas, studies that have ~~compiled robust datasets~~
1675 ~~suitable for evaluation of provided statistically rigorous estimates of~~ Spotted Owl site occupancy in
1676 California are rare. In the southern Cascades and interior Klamath provinces of California, where there
1677 are no demographic study areas, Farber and Kroll (2012) compiled data from 1995-2009 using a
1678 consistent and rigorous annual survey effort at 63 Northern Spotted Owl sites. Occupancy modeling
1679 showed that simple and pair Spotted Owl occupancy probabilities declined approximately 39% over the
1680 15 year period; site occupancy for any owl declined from 0.81 (0.59–0.93) to 0.50 (0.39–0.60), and pair
1681 occupancy declined from 0.75 (0.56–0.87) to 0.46 (0.31–0.61). In addition to providing estimates of
1682 occupancy from the interior of the range in California that is relatively understudied, this study also
1683 provides a ~~statistically~~ rigorous assessment of occupancy trends on private timberlands.

1684 As an example of declining populations at California demographic study areas, the number of observed
1685 owls on NWC has declined from a high of 195 owls in 1992 to low counts of 62-67 owls since 2012
1686 (Franklin et al. 2015). At HUP, the number of owls observed between 1992 and 2006 was between 60-70
1687 owls each year; a steep decline since then has resulted in only 30 owls observed in 2013 (Higley and
1688 Mendia 2013). At the GDR density study area, the number of occupied sites declined from about 120-
1689 140 sites for years 1992-2004 to ~~just over a low of 82~~ occupied sites in 2008 (~~exact numbers not~~
1690 ~~available~~; GDRC 2015). A partial recovery in number of occupied sites led to about 110 occupied sites by
1691 2012; the authors attributed this increase to removal of Barred Owls and an increase in suitable habitat
1692 (GDRC 2015). Several study areas north of California have also undergone dramatic declines.

1693 In the 97,000 acre Redwood National and State Parks, as many as 40 Northern Spotted Owl activity
1694 centers were identified during the 1990s. Occupancy rates are not available for the parks. However, by

Comment [LVD61]: 63.No, survey effort can be modeled and detection probabilities can vary over time. For example, you could do 2 surveys of owl sites in some years and 5 in others and you could get an unbiased estimate of occupancy for all years. The only difference is that detection probabilities would vary and the variance of the occupancy estimate would be higher (larger confidence intervals) in years with fewer surveys.

Comment [LVD62]: 64.True, but the variation in detection probabilities can be accounted for – that is what makes occupancy surveys so useful in comparison to the “old days” when we did “presence/absence surveys” and had to just hope that detection probabilities remained constant.

Comment [LVD63]: 65.To a lesser extent, this can be an issue for any NSO occupancy surveys, particularly if surveys continue during the late survey season in July and August when resident owls often make long movements within or even outside their usual home range.

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1695 2001 a large proportion of activity centers had become inactive, and subsequent intensive surveys
1696 revealed that most historical Spotted Owl territories now appear to be occupied by Barred Owls
1697 (Schmidt 2013). Data through 2012 indicated that at least 58 Barred Owl sites occurred within the parks,
1698 not including areas with single detections of Barred Owls. In 2012, Northern Spotted Owls were
1699 detected at just four territories in the parks, with only one pair observed; this was also the second
1700 consecutive year with no known reproduction of Northern Spotted Owl in the parks (Schmidt 2013).

1701 In contrast to the above studies at demographic study areas and at other well-monitored areas that
1702 showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the
1703 study area, several industrial timber companies have concluded that Northern Spotted Owl occupancy
1704 rates have been stable on their lands, and that this indicates stable populations (Calforests 2014). In
1705 2014, the California Forestry Association hosted a Northern Spotted Owl Science Forum, to which
1706 members of the association were invited to present on monitoring efforts and status of Spotted Owls on
1707 their property. Twelve landowners, timber management companies, and non-profit groups presented
1708 on various aspects of timber operations as they relate to Northern Spotted Owls. Presentations included
1709 data on Northern Spotted Owl surveys, numbers, and population parameters, although the information
1710 presented varied by participant. Reports on estimated occupancy rates were included in many
1711 presentations and are summarized in Table 8 for nine companies.

1712 As discussed above, valid estimates of occupancy require consistent survey efforts over time, and
1713 modeling of occupancy rate must take into account detection probability. These requirements were
1714 rarely met in the occupancy estimates and trends reported by the timber companies (Calforests 2014).
1715 There is no standardized monitoring protocol used across the timber companies, and methods
1716 employed have been highly variable. In some cases, the level of detail at which methods are described
1717 does not allow for evaluation of occupancy estimates.

1718 Of nine companies reporting on some aspect of occupancy on their ownership, five reported a stable
1719 trend in occupancy with one company reporting that the population size is variable. Two companies
1720 reported a mix of stable, declining, or increasing occupancy, depending on the time period or the
1721 portion of the owl population assessed. In most cases the companies have reported on counts of
1722 occupied sites or on naïve estimates of occupancy (the proportion of surveyed sites that are occupied in
1723 a given year) without consideration of detection probability. Counts of occupied sites and detection
1724 probability are both dependent on influenced by survey effort. An example of this can be seen in data
1725 submitted by Mendocino Redwood Company, which shows a correlation between survey effort and
1726 estimates of occupancy.

Comment [LVD64]: 66.Both of these variables are potentially dependent on a whole suite of variables including survey effort.

1727 Green Diamond Resource Company, as a participant in the rangewide coordinated demographic studies
1728 since 1990, has the longest history of banding and monitoring work among the companies. Results from
1729 Green Diamond Resource Company are included in the demography section. Although results on
1730 occupancy modeling are preliminary, modeling revealed a more than 30% decline in occupancy from
1731 1995-2013 (Dugger et al. in reviewin press). A reduction in the rate of decline in recent years was
1732 attributed to the removal of Barred Owl from portions of the study area.

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1733 Humboldt Redwood Company also has a fairly long history of monitoring, with consistent methods being
1734 used since 2002 and banding being conducted since 2003 as part of the HCP monitoring program (HRC
1735 2014). Monitoring under the Humboldt Redwood Company HCP samples a subset of the land ownership
1736 in each year. Twenty percent of lands are surveyed each year, with the entire property surveyed every
1737 five years. However, core sites are monitored annually, including determination of occupancy, whereas
1738 other sites are sampled on a rotating basis. Core sites were established to represent activity centers that
1739 have had a history of occupancy and reproduction, and the HCP provides higher habitat retention
1740 requirements for these core sites. Therefore, sites which are monitored annually are those which meet
1741 minimum habitat requirements and have a higher history of use by Northern Spotted Owl, resulting in a
1742 biased, skewed sample of all potential owl sites. The sampling scheme therefore results in biased
1743 estimates of occupancy for the all potential owls sites throughout the ownership as a whole. Also,
1744 because the non-core sites are sampled on a rotating basis, a different set of sites is sampled each year.
1745 It is unclear how this rotating sampling scheme may affect reported trends in occupancy. The sampling
1746 scheme included in the Humboldt Redwood Company HCP has the benefits of less intensive annual
1747 survey requirements and the ability to focus survey effort on sites with upcoming timber harvest or
1748 other management actions in order to meet the requirements of the HCP, but limits the ability to
1749 accurately determine occupancy rate for the ownership as a whole.

1750 Campbell Global, L.L.C. manages timber lands for multiple owners, and reported on occupancy rates for
1751 two ownerships in Mendocino County (Calforests 2014). All known active activity centers were surveyed
1752 annually to determine occupancy status. Occupancy was first presented using simple count data for
1753 years 2000-2013, with no apparent trend in occupancy over time. The Spotted Owl population was
1754 reported to be dynamic but stable on these ownerships. Campbell Global also presented preliminary
1755 results of modeled occupancy dynamics (including estimation of detection probability) using data from
1756 the same ownerships from 1990-2010. Modeling showed that occupancy probabilities for single Spotted
1757 Owls began to decline in 2003. Pair occupancy declined by 16-30% during the initial portion of the time
1758 period before stabilizing in 1997. These results show how simple counts or naïve estimates of occupancy
1759 will not necessarily reflect true occupancy rates.

1760 The Mendocino Redwood Company is the only other company to model occupancy rates taking into
1761 account detection probability (Calforests 2014). As with the lands managed by Campbell Global, L.L.C.,
1762 when occupancy was presented using counts or naïve estimates there was no apparent trend (years
1763 included were 2001-2013). However, when occupancy modeling was conducted for a subset of years
1764 2001-2008, a slight decline in occupancy was found. Occupancy modeling was not conducted on data
1765 from more recent years.

1766 The variability in methods used by companies, the tendency to report on counts or naïve estimates of
1767 occupancy without consideration of detection probability, the sometimes inconsistent methods used
1768 over time, along with the sometimes limited description of methods, makes it difficult to interpret the
1769 reported occupancy rates and trends for most companies. This leads to some difficulty in comparing
1770 reported rates in timber company reports to other published estimates of occupancy and does not
1771 support a strong finding that occupancy rates have been stable across these ownerships over time.

Comment [LVD65]: 67. It isn't necessarily biased unless these sites are used to draw inferences about all sites.

Comment [LVD66]: 68. A fixed block with a rotating panel is a perfectly legitimate sampling scheme that is used all the time particularly when there is a lot of spatial variability in the response variable of interest. I don't know the details of their sampling scheme, but it seems like a perfectly reasonable and unbiased approach to estimating trends in occupancy even though the mean estimates of occupancy for the ownership may be somewhat of an overestimate of the true value.

Comment [LVD67]: 69. Again, does this matter if the goal is to determine long term trends rather than the true mean estimate of occupancy?

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1773 **Table 8.** Occupancy estimates as presented in the Northern Spotted Owl Science Compendium in 2014 by
1774 participating timber companies with ownership in the range of the Northern Spotted Owl in California. See text for
1775 caution in interpreting these results.

Company	Pair Occupancy in 2013	Reported Occupancy Trend
Humboldt Redwood Company (Humboldt County)	0.85 (pairs only)	Stable
Sierra Pacific Industries (mainly Siskiyou and Shasta counties)	No rate provided, reported 48 known sites occupied	Stable
Conservation Fund (Mendocino and Sonoma counties)	No rate provided, reported 23 known sites occupied	Stable
Michigan-California Timber Company (Siskiyou County)	0.48	Stable
Green Diamond Resource Company (Humboldt and Del Norte counties)	0.83	1998-2008 Declining 2009-2011 Increase ¹
Crane Mills (mainly Tehama and Shasta counties)	No rate provided, reported 38 known sites occupied	No trend in occupancy noted
Mendocino Redwood Company (Mendocino and Sonoma counties)	0.69	Stable
Fruit Growers Supply Company (mainly Siskiyou County)	Approximately 0.95	Variable
Campbell Global (Mendocino, Siskiyou and Shasta counties)	>0.85 and >0.80 (singles) >0.85 and >0.70 (pairs) (estimates from 2010 occupancy analysis on two ownerships in Mendocino County)	Declining Stable

¹ The increase in occupancy starting in 2009 was attributed to the start of Barred Owl removals from the study area.

1778 Source-Sink Dynamics

1779 Pulliam (1988) was the landmark seminal publication on source-sink population dynamics. Since then,
1780 application of source-sink dynamics has been applied within many ecological studies to better
1781 understand movement (e.g., dispersal) interactions on the landscape while accounting for birth and
1782 death rates within population segments. Source populations are those in which reproduction exceeds
1783 carrying capacity thereby providing a surplus of individuals, whereas sink populations are those where
1784 mortality exceeds local reproduction (Pulliam 1988, Dias 1996, Watkinson and Sutherland 1995).
1785 Pseudo-sinks are populations that those populations that may be viable, but movement dynamics are
1786 difficult to distinguish based on complicated demographics and habitat connectivity (Watkinson and
1787 Sutherland 1995). These source-sink dynamics have been linked to habitat quality, generally with high

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quality habitat producing source populations, and low quality habitat producing sink populations (Dias 1996). Protected areas may serve different functions for vulnerable species depending on habitat quality and connectivity (Hansen 2011). Understanding source-sink populations can give us insight into appropriate and effective management actions that may benefit species habitat and populations at a local or range-wide level. For the Northern Spotted Owl, such principles are key to understanding connectivity (quality and function) between populations and how these populations may affect one another.

By applying source-sink modeling techniques and utilizing the immense amount of data available on Northern Spotted Owl life history and demography, Schumaker et al. (2014) characterized simulated potential Northern Spotted Owl movement dynamics between modeling regions and physiographic provinces noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). For California, the Northern Spotted Owl populations within the Klamath region (Klamath West and Klamath East modeling regions; California Klamath physiographic province) and the Inner California Coast Range modeling region were identified-projected by the model as source populations, while the California Coast Range and California Cascade physiographic provinces were identified as sink populations (Table 9). Source-sink strength was projected to be substantial for the East Cascade South modeling region (sink), Klamath East region (source), Inner California Coast region (source), California Coast province (sink), and California Klamath province (source).

Table 9. Model output of source and sink attributes within modeling region and physiographic province found in California (adapted from Table 2 in Schumaker et al. 2014). Includes percent of modeled range-wide population potential for each location, whether the location is-projected by the model to be a source or sink, and the strength of the sink/source as a percent of the best range-wide source or worst range-wide sink.

Location	Percent of population	Source or Sink	Source-Sink Strength
<i>Modeling Regions</i>			
East Cascade South	3.8	Sink	100
Redwood Coast	16.4	Sink	28.1
Klamath West	20.0	Source	51.1
Klamath East	17.1	Source	97.9
Inner California Coast	21.7	Source	100
<i>Physiographic Provinces</i>			
California Coast Range	16.6	Sink	100
California Cascades	2.8	Sink	35.9
California Klamath	36.4	Source	100

Schumaker et al. (2014) evaluated simulated hypothetical movement and contribution to overall population growth rate within modeling region and physiographic province source locations range-wide. Data for source locations in California is summarized in Table 10 and graphically in Figure 8. Klamath modeling regions (Klamath West and Klamath East) were projected to provide a flux of individuals within (e.g., Klamath West to Klamath East), and to the Cascade modeling regions (East Cascade South and West Cascades South), Redwood Coast, and Oregon Coast. Percent of simulated net flux was most notable from Klamath East to East Cascade South regions. The Inner California Coast modeling region provided a simulated flux of individuals to Klamath and East Cascade South regions. The California

Comment [LVD68]: 70. Again, it is important to make it clear that these are not real estimates of NSO movements or source-sink dynamics. This is all about a modeling exercise in which hypothetical owls behaving in ways dictated by a model respond to static habitat map that may or may not accurately reflect the habitat potential on the ground.

Comment [LVD69]: 71. Don't want to be a broken record but this makes it sound like Schumaker was analyzing data from the movements of real owls. This is all about hypothetical owls moving around in the cyberspace of some computer model.

Comment [LVD70]: 72. I think presenting this table and figure gives greater credence to a modeling exercise that the authors described as done: "... for the purpose of introducing new methodology—our intent is not to design, improve, or promote NSO management strategies." As the famous statistician George Box once said: "All models are wrong, but some are useful." I think the Schumaker paper provides a useful model of how source-sink dynamics might operate and the basis for experimental tests of the model predictions. But I think it would be a big mistake to assume the model accurately reflects what is actually happening on the ground within the NSO population. The single most compelling reason why this is true is because in most areas, barred owl numbers have now reached the point where NSO populations are just a fraction of their habitat potential. The reality is likely to be that the future source areas will be where barred owl populations are lowest and sinks will potentially occur where there used to be great NSO habitat that is now completely taken over by barred owls.

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1819 Klamath province was identified as a potential source providing a flux of individuals to the California
1820 Coast Range, California Cascades and Oregon Klamath provinces, with net flux most notable to the
1821 California Coast Range province.

1822 **Table 10.** Net Flux and $\Delta\lambda^R$ for modeling region and physiographic province source locations in California (adapted
1823 from Table 3 in Schumaker et al. 2014). Net Flux represents movement from one location to another. $\Delta\lambda^R$
1824 represents the change in overall population growth rate.

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
<i>Modeling Regions</i>			
Klamath West	Redwood Coast	36.2	3.9
	Oregon Coast	49.5	45.9
	Klamath East	12.7	19.1
Klamath East	East Cascade South	100	85.1
	West Cascades South	36.0	27.4
Inner California Coast	Klamath West	44.4	28.3
	Klamath East	19.7	18.4
	East Cascades South	30.4	22.4
<i>Physiographic Provinces</i>			
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

Comment [LVD71]: 73.1 recommend deleting this table and just providing the highpoints in the text.

1825
1826 While Schumaker et al. (2014) represents a modeling approach with all the inherent limitations of
1827 mathematical models that attempt to simulate complex ecological systems, it illuminates potential
1828 source-sink dynamics results and suggests that California's population of Northern Spotted Owls is likely
1829 a significant component of and source to the range-wide population. As a source, the Klamath region
1830 populations provide a source of owls to sink populations on the Coast and Cascade ranges. This concept
1831 is central to Furthermore, it provides the basis for designing landscape-level experiments to investigate
1832 source-sink dynamics relative to the protection of owl habitat, especially and the importance of
1833 dispersal habitat, for the continued persistence of Northern Spotted Owls across their range. However,
1834 this modeling exercise did not account for the competitive exclusion of Spotted Owls from their
1835 preferred habitat by Barred Owls (see Barred Owls below). If the Barred Owl threat is not adequately
1836 addressed, the habitat potential and source-sink dynamics from this modeling exercise would be
1837 dramatically altered and Spotted Owls may only be found in areas with low densities of Barred Owls.

Existing Management

1838
1839

Land Ownership Patterns in Northern Spotted Owl Range

1841 The laws and regulations governing management of forests in the range of the Northern Spotted Owl
1842 vary depending on ownership. For this reason, the following discussion on existing management is
1843 partitioned based on ownership, with lands governed by a common set of regulations. In general,
1844 federal timberlands in the range of the Northern Spotted Owl are governed by the NWFP, with some

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federal ownership subject to more restrictive management (e.g., National Parks). Although tribal lands are subject to federal regulations for timber management, the tribes in the range of the Northern Spotted Owl in California have developed Forest Management Plans (FMPs) and are discussed separately. Nonfederal lands in California must comply with the Forest Practice Rules for commercial timber harvest. There are several options for complying with the Forest Practice Rules when developing a THP depending on several factors including, but not limited to, size of ownership, presence of Spotted Owl activity centers, and qualification for an exemption. We present these options below and discuss the most important options in greater detail.

Federal lands contain less than half of the total forest land in the range of the Northern Spotted Owl (Mouer et al. 2011). Of an estimated 14.3 million acres of forested lands within the Northern Spotted Owl range in California, 6.4 million acres are publicly owned and 7.8 million acres are privately owned (2.3 million acres industrial and 5.5 million acres non-industrial) (Calforests 2013). Federal lands in the Northern Spotted Owl range in California are more concentrated in the interior portion of the range, with most USFS and BLM land occurring in the Klamath and Cascades provinces (Figure 9). The majority of the California Coast Province is under private ownership, though large tracts of public land occur along the coast, including both State and National parks. The most interior portion of the Northern Spotted Owl range in California (Cascades and eastern portion of Klamath provinces) has a combination of federal and private land, sometimes in a checkerboard pattern as a result of historical railway land grants (Figure 9). Tribal lands in California collectively represent 167,401 acres in the range of the Northern Spotted Owl and are mostly within the Coast Province and the western portion of the Klamath Province.

Critical Habitat Designation

In 2012, the USFWS revised the critical habitat designation for the Northern Spotted Owl (USFWS 2012). The purpose of critical habitat is to designate land distributed within the entire range of the Northern Spotted Owl that provides “features essential for the conservation of a species and that may require special management”, which includes forest types supporting the needs of territorial owl pairs throughout the year, including nesting, roosting, foraging, and dispersal habitat (USFWS website - <http://www.fws.gov/oregonfwo/species/data/northernspottedowl/CriticalHabitat/default.asp>). Critical habitat was identified using a modeling framework that considered both habitat requirements and demographic data, and considered uncertainties such as impacts of Barred Owl, climate change, and wildfire risk. Range wide, 9.29 million acres of critical habitat ~~is~~ are on federal land and 291,570 acres ~~is~~ are on state land. All private lands and the majority of state lands were excluded from the designation. A map of critical habitat for California is shown in Figure 10, which includes 2,014,388 acres on federal land, and 49,542 acres on state land. For management purposes, critical habitat only affects federal actions and do not provide additional protection on non-federal lands, unless proposed activities involve federal funding or permitting.

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1881 **Federal Lands**

1882 *Northwest Forest Plan*

1883 In the early 1990s, concern was raised regarding the adequacy of federal plans to protect the Northern
1884 Spotted Owl. Litigation resulted in a court injunction on harvest of owl habitat (mature and old-growth
1885 forest). In 1993, President Clinton directed the Forest Ecosystem Management Assessment Team
1886 (FEMAT) to develop long-term management alternatives for maintaining and restoring habitat
1887 conditions to maintain well-distributed and viable populations of late-successional- and old-growth-
1888 related species. The FEMAT was instructed to maintain and restore habitat conditions for the Northern
1889 Spotted Owl (as well as the Marbled Murrelet). The FEMAT was also instructed to maintain and restore
1890 habitat conditions to support viable populations, well-distributed across current ranges, of all species
1891 known or reasonably expected to be associated with old-growth habitat conditions; and to maintain or
1892 create a connected, interactive, old-growth forest ecosystem on federal lands (FEMAT 1993; Thomas et
1893 al. 2006). In developing alternatives, the members of FEMAT relied heavily on recently completed
1894 conservation assessments, including a regional conservation strategy for the Northern Spotted Owl
1895 (Thomas et al. 1990). The analysis of the FEMAT alternatives in a final supplemental environmental
1896 impact statement (USDA and BLM 1994a) led to adoption of the land-allocation strategy contained in
1897 the record of decision (USDA and BLM 1994b), hereinafter referred to as the Northwest Forest Plan. The
1898 NWFP amended nineteen existing USFS and seven BLM resource management plans within the range of
1899 Northern Spotted Owl. The intention of the NWFP is to improve current conditions and alter past
1900 practices that were detrimental to late-successional species by protecting large blocks of remaining late-
1901 successional and old-growth forests, and to provide for the regrowth and replacement of previously
1902 harvested late-successional forest stands. To help facilitate decision-making and issue resolution during
1903 the implementation of the NWFP, the Regional Ecosystem Office was formed and is made up of
1904 members from USFS, BLM, National Park Service (NPS), and Environmental Protection Agency (EPA).

1905 The NWFP covers approximately 24 million acres of federal land within the range of the Northern
1906 Spotted Owl, about 67% of which are allocated in one of several “reserved” land use designations (see
1907 discussion of designations and Table 11). In California, approximately 3.5 million acres of federal lands
1908 fall under the NWFP as reserved land. This is approximately 6 percent of the 57 million acres of forested
1909 habitat within the Northern Spotted Owl’s California range. Reserved lands are intended to support
1910 groups of reproducing owl pairs across the species’ range. Unreserved land is defined as the federal land
1911 between reserved lands and is intended to provide recruitment of new owls into the territorial
1912 populations and is important for dispersal and movement of owls between larger reserves.

1913 **Table 11.** Land-use allocations in the Northwest Forest Plan (adapted from Thomas et al. 2006)

Land-use allocation	Approximate Acres (%)
Congressionally reserved areas	7,323,783 (30)
Late-successional reserves	7,433,970 (30)
Managed late-successional reserves	102,242 (1)
Adaptive management areas	1,522,448 (6)

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Administratively withdrawn areas	1,477,730 (6)
Riparian reserves	2,628,621 (11)
Matrix	3,976,996 (16)
<i>Total</i>	<i>24,465,790 (100)</i>

1914

1915 Reserved land includes late-successional reserves (LSRs), managed late-successional areas (managed
1916 LSAs), congressionally reserved lands, and larger blocks of administratively withdrawn lands. The LSRs
1917 cover about 30% of the NWFP area and were located to protect areas with concentrations of high-
1918 quality late-successional and old-growth forest on federal lands and to meet the habitat requirements of
1919 the Northern Spotted Owl (Thomas et al. 2006). Most LSRs were designed to accommodate at least 20
1920 pairs of Northern Spotted Owls (FEMAT 1993). Timber harvesting is generally prohibited in LSRs.
1921 However, silviculture treatments (including thinning in stands less than 80 years old west of the
1922 Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit
1923 the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging
1924 is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events
1925 such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that
1926 were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National
1927 Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district
1928 plans as being withdrawn from timber production and include recreational and visual areas, back
1929 country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily
1930 in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with
1931 smaller amounts of reserved lands on the coast (Figure 11).

1932 Unreserved land includes the matrix, adaptive management areas (AMAs), riparian reserves, small tracts
1933 of administratively withdrawn lands, and other small reserved areas such as 100-acre owl core areas.
1934 The matrix represents the federal land not included in any of the other allocations and is the area where
1935 most timber harvesting and other silviculture activities occur. However, the matrix does contain non-
1936 forested areas as well as forested areas that may be unsuited for timber production. Three of the major
1937 standards and guidelines for matrix land management are: (1) a renewable supply of large down logs
1938 must be in place; (2) at least 15% of the green trees on each regeneration harvest unit located on
1939 National Forest land must be retained; and (3) 100 acres of late-successional habitat around owl ACS
1940 must be protected (USDA and BLM 1994b). Timber harvesting is allowed within AMAs and like the
1941 matrix lands, AMAs are subject to the standards in the NWFP and in individual forest and district plans.
1942 Riparian reserves are a system of reserves defined by a set distance on each side of perennial and
1943 intermittent streams (Thomas et al. 2006) and may provide dispersal habitat for Northern Spotted Owls.

1944 Standards and guidelines for the management of both reserved and unreserved lands are described in
1945 the Record of Decision associated with the NWFP (USDA and BLM 1994b, Attachment A). A summary of
1946 management on each land use designation is provided below.

1947 Late Successional Reserves:

Comment [LVD72]: 74. Throughout most of the document you have written out “activity centers” and now you switch to ACs without defining what the abbreviation represents. If you are going to use “ACs”, you should start from the beginning of the document, define it where first used and then use it throughout.

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1948 Before habitat manipulation activities occur on LSRs, management assessments must be prepared.
1949 These assessments include a history and inventory of overall vegetative conditions, a list of identified
1950 late-successional associated species existing within the LSR, a history and description of current land
1951 uses within the reserve, a fire management plan, criteria for developing appropriate treatments,
1952 identification of specific areas that could be treated under those criteria, a proposed implementation
1953 schedule tiered to higher order plans, and proposed monitoring and evaluation components to help
1954 evaluate if future activities are carried out as intended and achieve desired results. The following
1955 standards must be followed for timber management activities in LSRs:

- 1956 • West of the Cascades – No timber harvest is allowed in stands over 80 years old. Thinning (pre-
1957 commercial and commercial) may occur in stands up to 80 years old in order to encourage
1958 development of old-growth characteristics.
- 1959 • East of the Cascades and in California Klamath Province – Silviculture activities should be
1960 designed to reduce catastrophic insect, disease, and fire threats. Treatments should be designed
1961 to provide fuel breaks but should not generally result in degeneration of currently suitable owl
1962 habitat or other late-successional conditions. Risk reduction activities should focus on young
1963 stands but activities in older stands may be undertaken if levels of fire risk are particularly high.
- 1964 • Salvage in disturbed sites of less than 10 acres is not appropriate. Salvage should occur only in
1965 stands where disturbance has reduced canopy closure to less than 40%. All standing living trees
1966 should be retained, including those injured (e.g., scorched) but likely to survive. Snags that are
1967 likely to persist until late-successional conditions have developed should be retained.
1968 Appropriate levels of coarse woody debris should be retained. Some salvage will be allowed
1969 when it is essential to reduce fire risk or insect damage to late-successional forest conditions.
1970

1971 Managed Late Successional Areas:
1972 Innovative silviculture techniques may be applied in managed LSRs. Proposed management activities are
1973 subject to review by the Regional Ecosystem Office, although some activities may be exempt from
1974 review. Within managed LSRs, certain silviculture treatments and fire hazard reduction treatments are
1975 allowed to help prevent complete stand destruction from large catastrophic events such as high
1976 intensity, high severity fires; or disease or insect epidemics. Managed LSAs should have management
1977 assessments as described for LSRs. Standards and guidelines for multiple-use activities other than
1978 silviculture are the same as for LSRs.

1979 Congressionally Reserved Lands:
1980 These lands are managed according to existing laws and guidelines established when the lands were set
1981 aside, and are generally managed to preserve natural resources (e.g., The National Park Service Organic
1982 Act of 1916, the National Parks Omnibus Management Act of 1998).

1983 Administratively Withdrawn Areas:
1984 There are no specific timber/silviculture standards and guidelines associated with administratively
1985 withdrawn areas. These areas have been identified as withdrawn from timber production in forest or
1986 district plans.

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1987 Riparian Reserves:

1988 Riparian Reserves are managed to meet objectives of the Aquatic Conservation Strategy to help protect
1989 fish habitat and restore water quality. Timber harvest is prohibited within riparian reserves, including
1990 fuelwood cutting and salvaging (although some exceptions are made). Fuel treatment and fire
1991 suppression strategies and practices implemented within these areas are designed to minimize
1992 disturbance.

1993 Matrix Lands:

1994 Matrix lands are open to timber harvest subject to the standards in the NWFP and in the individual
1995 forest and district plans. The objective for Matrix lands is to “provide coarse woody debris well
1996 distributed across the landscape in a manner which meets the needs of species and provides for
1997 ecological functions” (USDA and BLM 1994b). Standards for Matrix lands in the NWFP include:

- 1998
- 1999 • Coarse woody debris that is already on the ground is retained and protected from disturbance
- 2000 to the greatest extent possible during logging and other land management activities that might
- 2001 destroy the integrity of the substrate.
- 2002 • Retention of at least 15% of the area associated with each cutting unit (stand).
- 2003 • In general, 70% of the total area to be retained should be aggregates of moderate to larger size
- 2004 (0.5 to 2.5 acres or more) with the remainder as dispersed structures (individual trees, and
- 2005 possibly including smaller clumps less than 0.5 acres). Patches and dispersed retention should
- 2006 include the largest, oldest live trees, decadent or leaning trees, and hard snags occurring in the
- 2007 unit. Patches should be retained indefinitely (i.e., through multiple rotations to provide support
- 2008 for organisms that require very old forests).
- 2009 • 100 acres of the best Northern Spotted Owl habitat must be retained as close to the nest site or
- 2010 owl activity center as possible for all known activity centers located on federal lands in the
- 2011 matrix and AMAs. These areas are managed in compliance with LSR management guidelines and
- 2012 are to be maintained even if Northern Spotted Owls no longer occupy them.

2013

2014 Adaptive Management Areas:

2015 AMAs were intended to be focal areas for implementing innovative methods of ecological conservation
2016 and restoration, while meeting economic and social goals. Although there have been some successes in
2017 experimentation, most AMAs have been managed similarly to Matrix lands (Thomas et al. 2006). The
2018 NWFP established 10 AMAs, two of which are in California: Goosenest in northeastern California and
2019 Hayfork, which is located mostly in the Klamath province. One of the primary goals of the Goosenest
2020 AMA is to investigate means of accelerating the development of late-successional forest properties in
2021 pine forests. Mechanical treatments (forest thinning) and prescribed fire have been used experimentally
2022 to evaluate effect on development of late-successional forest properties in pine forests (Ritchie 2005).
2023 The emphasis for Hayfork is to investigate effects of forest management practices on the landscape,
2024 including partial cutting, prescribed burning, and low-impact approaches to forest harvest.

2025 Standards and guidelines for LSRs and Congressionally Reserved Areas are followed where they fall
2026 within AMAs.

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2027 *Section 7 Consultations*

2028 Section 7 of the Endangered Species Act requires all federal agencies to consult with the USFWS to
2029 ensure that any timber management action authorized, funded, or carried out by federal agencies is not
2030 likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical
2031 habitat (16 U.S.C. § 1536 subd. (a); 50 C.F.R. § 402). Section 7 requires the permitting instrument (i.e.,
2032 biological opinion or letter of concurrence) to include measures to minimize the level of take to
2033 Northern Spotted Owl. Examples of take minimization measures may include:

- 2034 • Restricted use of heavy equipment during the breeding season
- 2035 • Retention of larger trees owl nesting/roosting and foraging habitat
- 2036 • Retention of large snags and down logs within thinning units
- 2037 • Retention of hardwoods
- 2038 • Limited thinning within Riparian Reserves
- 2039 • Monitoring and surveys for Northern Spotted Owl throughout projects

2040

2041 *Forest Stewardship Contracting*

2042 The Agricultural Act of 2014 (“Agricultural Act of 2014, Section 8205, Stewardship End Result
2043 Contracting Projects”) grants the USFS and BLM authority to enter into stewardship contracting with
2044 private persons or public entities to perform services to “achieve land management goals for the
2045 national forests or public lands that meet local and rural community needs” (USFS 2009). Agreements
2046 allow contractors to remove forest products (goods) in exchange for performing restoration projects
2047 (services), the cost of which is offset by the value of the goods. Agreements may extend for up to 10
2048 years.

2049 Since the new authority became law, the USFS has awarded more than 30 stewardship projects. It is
2050 unknown how many USFS stewardship projects are in California. There are some inconsistencies in
2051 information regarding the number of BLM stewardship projects. The BLM Stewardship Contracting Fact
2052 Sheet
2053 ([http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.da](http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf)
2054 [t/stcontrBLM_Fact0115.pdf](http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf)) lists two stewardship projects that do not occur in California. However, the
2055 BLM website (http://www.blm.gov/wo/st/en/prog/more/forests_and_woodland/0.html) lists three
2056 forest stewardships in California: Weaverville Community Forest, South Knob, and Hobo Camp.

2057 *Bureau of Land Management*

2058 The standards and guidelines from the NWFP apply except where existing resource management plans
2059 are more restrictive or provide greater benefits to late-successional forest related species.

2060 Headwaters Forest Reserve

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Headwaters Forest Reserve is located in the north coast region of California and was purchased by the Secretary of Interior and the State of California in 1999 to preserve a large stand of old-growth redwood forest. The Headwaters Forest Reserve Resource Management Plan (USDOI et al. 2003; USDOI and BLM 2004a) was developed with the goal to restore and maintain ecological integrity and to study ecological processes within the Reserve to improve management. Recreation and other management activities are constrained as necessary to be consistent with that primary goal. Old-growth forest habitat within the Reserve is managed to leave those systems undisturbed as core areas of optimal habitat. Second-growth forests are managed using tree thinning for restoration of old-growth characteristics. Priority is given to revegetating watershed restoration sites in old-growth areas and to treating harvested stands with old-growth remnants. Harvested stands that comprise early-mature and older seral stages (i.e., stands with an average stem diameter over 12 inches) are generally not thinned. Density-management treatments do not yield commercial forest products; all biomass is left on-site and may be lopped and scattered, piled and burned, or chipped. Chain saws, mechanical brush cutters, and chippers may be used. Permanent or temporary roads or skid trails are not developed for access for treatment sites, but temporary access routes may be developed where they will be subsequently removed during watershed restoration activities.

The desired outcome for Northern Spotted Owl is protection of existing habitat and expansion of suitable habitat for nesting, roosting, foraging, and dispersal habitat at the Reserve. The Resource Management Plan allows for the restoration of up to 2,757 acres of previously harvested stands. No suitable habitat for Northern Spotted Owl is to be removed or degraded during watershed restoration, forest restoration, or trail development. To the extent practicable, activities will be buffered from Northern Spotted Owl nesting habitat during the period of February 1 through July 31 by the use of vegetative screening or topographic screening and establishment of seasonal operating periods or a distance buffer of up to 0.25 mile. Off trail hiking is prohibited year-round.

Fuels in second-growth forests are managed through tree thinning with materials lopped and scattered, piled and burned, or chipped; broadcast burning is not employed within the Reserve. Fuels are not managed in old-growth forests and generally not in second-growth forest once they achieve early-mature seral stage. Fire suppression uses a minimum-impact strategy. In second-growth forests dozers may be used; resource damage will be minimized and full rehabilitation of dozer fire lines will be required after fire suppression. In old-growth forests road access will be limited to existing road systems; hand crews or helicopter bucket drops may be deployed to attempt to contain fire.

King Range National Conservation Area

The King Range National Conservation Area (NCA) is located along the northern California coast about sixty miles south of Eureka and 200 miles north of San Francisco. The King Range NCA Management Plan (USDOI and BLM 2004b; USDOI and BLM 2005) applies to 68,000 acres of forested land. All of the forested lands in the planning area have been designated as a LSR under the NWFP, and therefore must be managed to promote late-successional forest characteristics. All active forest management activities in the Management Plan are focused only in the Front Country Zone, 25,661 acre zone representing a broad mix of uses and tools for management. Forest management activities in this zone are intended to

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2100 develop more natural stand characteristics in areas that were previously harvested, improve watershed
2101 and fisheries health, and protection from wildfire risk. Some of these previously-logged areas have
2102 burned in high intensity fires, or are at risk for future fires of stand-replacing intensity. The primary goal
2103 in silvicultural treatments is to increase the Douglas-fir component in tanoak dominated stands, and
2104 “fireproof” this Douglas-fir component so that it has a greater chance to reach maturity.

2105 The Management Plan calls for the protection of sufficient Northern Spotted Owl habitat to attract and
2106 support 20 breeding pairs within the King Range NCA, as well as monitoring of known owl sites and
2107 periodic surveys in suitable habitat. At the time of the Management Plan development (2004), there
2108 were 12-14 known Spotted Owl activity centers in the King Range NCA. No timber harvests takes place in
2109 those activity centers.

2110 *National Park Service*

2111 Redwood National and State Parks

2112 Redwood National Park was established in 1968 and was expanded in 1978. Three California state parks
2113 established in the 1920s—Prairie Creek Redwoods State Park, Del Norte Coast Redwoods State Park, and
2114 Jedediah Smith Redwoods—were included within the 1968 congressionally designated national park
2115 boundary. Since 1994, the four park units have been managed jointly as Redwood National and State
2116 Parks (RNSP) to the greatest extent possible, although the state parks are administered by the California
2117 Department of Parks and Recreation and the national park is administered by the NPS. Collectively,
2118 RNSP covers approximately 131,983 acres of land in northwest California reaching from the shoreline of
2119 the Pacific Ocean to the mountains of the Coast Range.

2120 In 2000, a joint federal-state management plan was developed to provide a clearly defined, coordinated
2121 direction for resource preservation and visitor use and a basic foundation for managing these four parks
2122 (NPS 2000a, NPS 2000b). There are nine management zones within the RNSP, each with different types
2123 and levels of use, management, and facilities that are allowed. Three zones cover most of the combined
2124 park area – the two backcountry zones (42.1% mechanized and 13.3% nonmechanized), and the
2125 primitive zone (32.6%). The backcountry zones and primitive zone have the most restricted access, and
2126 resource modification and degradation from visitor use in these zones is low. The remaining 12% of the
2127 park area is made up of six relatively small zones which are managed for various resources and for
2128 visitor operational needs.

2129 The RNSP General Management Plan (NPS 2000b) includes programs for watershed restoration,
2130 vegetation management, cultural resource management, interpretation and education, and facility
2131 development. Under the watershed restoration program, abandoned logging roads that contribute
2132 unnatural amounts of sediments into streams or threaten redwoods along park streams will be removed
2133 or treated to reduce erosion. The vegetation management program includes use of silvicultural
2134 techniques in second-growth forests to accelerate the return of characteristics found in old-growth
2135 forests and management of fire to support resource management strategies, including restoration of
2136 fire in old-growth forests.

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2137 Prior to timber removal, the NPS will evaluate trees that are potential suitable nesting habitat for
2138 Northern Spotted Owl. The NPS take measures to reduce noise disturbance and loss of suitable habitat
2139 within one mile of occupied and unsurveyed potential suitable nesting habitat by operating outside the
2140 breeding season, using quiet equipment, or by implementing daily limited operating periods for heavy
2141 equipment during the breeding season. Protective buffer zones are used around known owl nest sites
2142 where visitor use activities are likely to result in disturbance.

2143 In 1978, Congress expanded RNSP to include 38,000 acres that had been logged between 1950 and 1978
2144 using clearcut tractor logging. With the expansion of the RNSP, commercial operations including active
2145 forest management and silviculture thinning ceased which resulted in second-growth forest conditions
2146 “considered unhealthy from both a silviculture and an ecological standpoint” (NPS 2008, NPS 2009a).
2147 Many of the second-growth forest stands were primarily high-density, even-aged Douglas-fir stands with
2148 little canopy structure and no understory development. The focus of second-growth forest restoration is
2149 to reduce stand density (thinning) to promote growth of remaining trees while protecting adjacent old-
2150 growth forests, as well as maintaining water quality in riparian habitats, minimizing tanoak tree
2151 disturbance, and minimizing excessive fuel build-up on the forest floor.

2152 In 2009, the NPS planned to apply thinning prescriptions throughout 1,710 acres in the South Fork of
2153 Lost Man Creek, with the prescription dependent upon slope steepness, available road access, presence
2154 of streams and wetlands, tanoak density, and proximity to old growth forest.

2155 The USFWS issued a Biological Opinion (file number 8-14-2004-2133 81331-2008-F-00027, dated
2156 December 19, 2007) that concurred with the NPS determination that the project may affect but is not
2157 likely to adversely affect the Northern Spotted Owl. The project was expected to alter approximately
2158 1,539 acres of suitable Northern Spotted Owl habitat. However, the habitat was considered poor quality
2159 and the short-term adverse effects on owls from habitat alteration to be negligible. The project was
2160 expected to have long-term benefits for Northern Spotted Owl due to retention and protection of
2161 deformed trees and snags, and habitat improvement through acceleration of development of late-
2162 successional forest structure.

2163 In 2011, Redwood National Park completed a project to thin about 1,700 acres of second growth forest
2164 in the South Fork of Lost Man Creek (near the community of Orick) to accelerate the restoration of old-
2165 growth characteristics and functions.

2166 The RNSP General Management Plan called for preparation of a comprehensive trail and backcountry
2167 management plan to guide the development of an expanded trail system and prescribe policies and
2168 regulations for the use of backcountry areas by hikers, bicyclists, and equestrians. The Trail and
2169 Backcountry Management Plan (NPS 2009b) details the construction of seven hiking trails totaling 14.6
2170 miles, establishment of two bike trails totaling 10.3 miles, and construction of two new backcountry
2171 camps. Avoidance and minimization measures during construction include above ambient noise
2172 producing work conducted outside of the marbled murrelet noise restriction period (March 24-
2173 September 15) and Northern Spotted Owl presence surveys prior to construction (NPS and CDPR 2013).

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2174 Fire management in RNSP includes suppression of wildfires, prescribed fire, mechanical fuel reduction,
2175 fire ecology research and fire effects monitoring, and fire operations planning (NPS 2010a, NPS 2010b).
2176 Fire suppression preparations include installing water tanks, preparing access roads, and removing
2177 hazardous fuels. Management actions are designed to avoid or minimize adverse effects on listed,
2178 proposed, or candidate threatened or endangered species and minimizes the effects on sensitive
2179 species. The NPS has developed guidelines to reduce or eliminate potential adverse effects on sensitive
2180 species from fire suppression in RNSP.

2181 Point Reyes National Seashore and Muir Woods National Monument

2182 The Point Reyes National Seashore (PRNS) was established in 1962 and is located along the coast just
2183 north of San Francisco. The General Management Plan and Environmental Impact Statement for PRNS
2184 are currently under development.

2185 Due to a better understanding of the role of fire in ecosystem preservation and reducing fire risk, in
2186 2004 the NPS proposed to revise PRNS's Fire Management Plan to expand the use of prescribed fire and
2187 mechanical treatment for all lands under its management NPS 2004). In 2006, the Operational Strategy
2188 for the Fire Management Plan was published (NPS 2006a). The planning area for the Fire Management
2189 Plan includes the 70,046-acre PRNS as well as 18,000 acres of the Northern District of Golden Gate
2190 National Recreation Area. The Fire Management Plan allows up to 3,500 acres per year to be treated
2191 using prescribed fire and mechanical treatments. Measures in Northern Spotted Owl habitat include:

- 2192 • Annually identify and map areas where Spotted Owls are nesting.
2193 • Protect occupied and previously used nest sites from unplanned ignitions.
2194 • Do not conduct prescribed burns within 400 meters of an occupied or previously used nest
2195 site.
2196 • Do not conduct mechanical treatments with mechanized equipment within 400 meters of an
2197 occupied or previously used nest site between February 1 and July 31 (breeding season).
2198 • Conduct post-treatment monitoring to ascertain any impacts.
2199

2200 Muir Woods National Monument is managed by the NPS as part of the Golden Gate National Recreation
2201 Area. The General Management Plan Environmental Impact Statement for the Golden Gate National
2202 Recreation Area and Muir Woods was completed in 2014 (NPS 2014). The Record of Decision was
2203 expected to be completed in spring 2014 but has not been completed to date.

2204 The Fire Management Plan for Muir Woods allows up to 595 acres to be treated per year using
2205 mechanical treatments and prescribed fire (NPS 2006b). Measures to protect Northern Spotted Owl
2206 include:

- 2207 • Treatment activities or any noise generation above ambient noise levels will not occur within
2208 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential
2209 Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as

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- 2210 surveys conforming to accepted protocol have determined that the site is unoccupied or non-
2211 nesting or nest failure is confirmed.
- 2212 • Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially
2213 alter the percent cover of canopy overstory and will preserve multilayered structure. When
2214 shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy
2215 will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency
2216 vehicle clearance.
 - 2217 • Prior to fire management activities, project areas will be surveyed for the presence of dusky
2218 footed woodrat nests. If feasible, woodrat nests will be protected.
 - 2219 • Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a
2220 determination is made that the native tree presents a clear hazard in the event of a fire or
2221 cutting is the only option to reduce high fuel loading.
 - 2222 • The fire management officer will arrange for qualified biologists to conduct post-project
2223 monitoring to determine short- and long-term effects of fire management actions on activity
2224 centers if resources are available.

2225 Tribal Lands

2226 Hoopa Valley Indian Reservation

2228 The Hoopa Valley Indian Reservation is the largest reservation in California encompassing 90,767 acres,
2229 and located in the northeastern corner of Humboldt County. The Hoopa Valley Tribe has recently
2230 adopted a revised Forest Management Plan (FMP) covering the period of 2011-2026 (Higley 2012). The
2231 annual allowable timber harvest has been determined to be 8.889 million board feet (MBF) net per year
2232 of conifer volume and 3.1 MBF net of hardwood volume to be harvested within the Reservation.
2233 Northern Spotted Owl habitat losses are expected from implementation of the FMP due to timber
2234 harvest, urban development, road construction, and prairie restoration. About 8,980 acres of roosting-
2235 foraging and nesting-roosting-foraging habitat are estimated to be lost to timber harvest over the period
2236 covered by the FMP. These acres will be temporarily rendered unsuitable to Northern Spotted Owl,
2237 although the FMP notes that habitat will “recover eventually to at least foraging dispersal but likely to
2238 roosting-foraging habitat...within 30-40 years because of the retention of large structures within all
2239 units” (Higley 2012). Implementation of the FMP and associated projects will result in a decline in total
2240 suitable habitat by approximately 4.4% by the end of the planning period in 2026. Dispersal habitat will
2241 be reduced by approximately 4.9% at the end of 2021 but is expected to rebound to a net reduction of
2242 0.9% by 2026.

2243 The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late
2244 successional reserves to the north, south, and east, and Redwood National Park to the northwest. The
2245 reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40
2246 pairs of owls at all times during the planning period. However, the plan notes this number of Northern
2247 Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009
2248 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl

Comment [LVD73]: 75. Seems a little bizarre given that it is a relatively small block within a sea of NSO habitat and owl sites.

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2249 detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning
2250 in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

2251 Eight forested management units noted in the FMP will retain Northern Spotted Owl dispersal habitat.
2252 None of the forested management units will dip below 50% cover of dispersal or higher quality habitat.
2253 The lowest level of owl habitat retention will occur within the Hopkins management unit, which at 72%
2254 at the time of the publication of the FMP, was projected to drop to 64% in 2012 and increase to 81% by
2255 2026.

2256 The FMP includes management actions to mitigate affects to Northern Spotted Owl including land
2257 allocation restrictions, requirements for structural retention within timber sale units and hardwood
2258 management guidelines, and are inclusive of:

- 2259 • The no cut land allocation includes 24,581 acres of which 21,104 acres were forested as of 2011
2260 with stem exclusion or larger size class strata including 10,134 acres of old growth.
- 2261 • 2,819 acres are allocated as reserved for threatened and endangered species. 73 acres are
2262 specifically reserved to protect Northern Spotted Owl nesting core areas.
- 2263 • Seasonal restrictions will apply to all disturbance activities resulting from logging, site
2264 preparation, stand improvement, burning, road construction or reconstruction, and watershed
2265 restoration projects, etc. within 0.25 miles of any known Northern Spotted Owl pair at least until
2266 nesting status is determined from February 1 until July 31. Activities, which modify suitable
2267 nesting/roosting habitat, such as logging, will be further restricted until September 15 of each
2268 year or until the young owls are determined to be capable of moving away from the area or the
2269 reproductive attempt has been determined to have failed. For territories that have been
2270 surveyed continually and found to be unoccupied for 2 or more years, no restrictions shall be
2271 imposed.

2272 *Yurok Indian Reservation*

2273 The Yurok Indian Reservation is located in Del Norte and Humboldt counties inclusive of one-mile on
2274 each side of the Klamath River along a 44-mile stretch. There are approximately 59,000 acres in the
2275 entire Yurok Indian Reservation, and of these, approximately 3,320 acres are forested Tribal trust lands
2276 (i.e., land that the federal government holds legal title to but the beneficial interest remains with the
2277 Tribe), and 2,171 acres are forested allotted lands held in trust (Erler 2012). The remaining lands are fee
2278 lands (i.e., land acquired by the Tribe under legal title outside the boundaries of the Reservation, and in
2279 this case is primarily owned by Green Diamond Resource Company), which are managed intensively for
2280 timber products. Total forested Tribal ownership is 36,637 acres.

2281 The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all
2282 Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for intensive
2283 surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then
2284 dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites.
2285 The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest

Comment [LVD74]: 76.This needs to be updated with the recent acquisitions of Pecwan, Bear and some of Blue Creeks from Green Diamond.

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2286 reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity
2287 centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl
2288 habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on
2289 disturbance activities within 0.25 mile of Northern Spotted Owl nest.

2290 *Round Valley Indian Reservation*

2291 The Round Valley Indian Reservation encompasses about 23,200 acres in Mendocino County. More than
2292 two thirds of this area is off-reservation trust land. A total of 2,837 acres are allocated as “Available”
2293 under the Round Valley Indian Reserve FMP (Baldwin, Blomstrom, Wilkinson and Associates 2006),
2294 which means that programmed timber harvest may be allowed. As of 2006, there were eight known
2295 pairs of Northern Spotted Owl either nesting, roosting, or foraging on the Reservation. Approximately
2296 80% of the Reservation could be considered as suitable owl habitat, according to the FMP’s
2297 Environmental Assessment (2006). The FMP would impact about 13% of the 22,150 acres of suitable
2298 habitat on the Reservation. Uneven-aged forest management including single-tree and group selection
2299 is the preferred method, with a 20 year cutting cycle and 100 year rotation, although limited even-aged
2300 management is allowed in specific cases. Harvest is expected to be about 3.4 MFB/acre.

2301 **Nonfederal Land**

2302 *History of Timber Management on Nonfederal Lands and the Forest Practice Rules*

2303 The California Department of Forestry and Fire Protection (CAL FIRE; <http://www.calfire.ca.gov/>)
2304 enforces the laws that regulate logging on privately-owned lands in California. These laws are found in
2305 the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will
2306 also preserve and protect California’s fish, wildlife, forests, and streams. Additional rules enacted by the
2307 State Board of Forestry and Fire Protection (BOF) are found in state regulations and are collectively
2308 referred to as the Forest Practice Rules. The purpose of the Forest Practice Rules is to implement the
2309 provisions of the Forest Practice Act in a manner consistent with other laws, including the California
2310 Environmental Quality Act (CEQA) of 1970, the Timberland Productivity Act of 1982, the Porter Cologne
2311 Water Quality Act, and the California Endangered Species Act (CESA).

2312 CAL FIRE ensures that private landowners abide by these laws when harvesting trees. Although there are
2313 specific exemptions in some cases, compliance with the Forest Practice Act and the Forest Practice Rules
2314 apply to all commercial harvesting operations for private landowners from ownerships composed of
2315 small parcels to large timber companies with thousands of acres.

2316 A Timber Harvesting Plan (THP) is generally the environmental review document submitted by
2317 landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the
2318 steps that will be taken to prevent damage to the environment. THPs are prepared by Registered
2319 Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process

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2320 substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber
2321 harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

2322 In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by
2323 the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These
2324 biologists would become the first “designated biologists” who would consult on proposed THPs.
2325 Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules
2326 and procedures that would be adopted in the event of listing. The rules identified descriptions of
2327 Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for
2328 timber operations to avoid take. The rules called for consultations between plan proponents and
2329 Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to
2330 amend the initially adopted emergency rules; amendments to the rules occurred several times as
2331 knowledge of the Northern Spotted Owl increased and with experience gained through implementation
2332 of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and
2333 919.10 [939.10] in March 1991, which describe options and procedures that can be used in THPs to
2334 avoid take of Northern Spotted Owl or to proceed under incidental take authorization.

2335 Section 919.9 [939.9] includes subsections (a) through (g), which are procedures (referred to as
2336 “options”) among which THP submitters must select and then must follow for THPs within the range of
2337 the Northern Spotted Owl or the “Northern Spotted Owl Evaluation Area” as defined in the Forest
2338 Practice Rules, and for THPs that are situated outside of this Evaluation Area that are within 1.3 miles of
2339 known owl activity centers. The option that is selected must meet on-the-ground circumstances. The
2340 information that each option requires is to be used by CAL FIRE to evaluate whether or not the proposed
2341 timber operations under the THP would result in unauthorized Northern Spotted Owl take. Subsections
2342 (a), (b), (c) and (f) involve CAL FIRE consulting with a Spotted Owl Expert (SOE). An SOE is defined in the
2343 Forest Practice Rules as a person with requisite documented education and experience whose
2344 qualifications have been referred by CAL FIRE to USFWS or the Department for evaluation.

2345 Subsection (a) provides the project proponent the option before a THP is filed of requesting an SOE to
2346 complete a preliminary review of the proposed timber operations to evaluate whether Northern
2347 Spotted Owl take would occur. The SOE must apply the criteria for Northern Spotted Owl take avoidance
2348 specified in Section 919.10 [939.10], and must inform the project proponent whether the proposed
2349 timber operations would or would not cause take. In practice, if an SOE concludes take would be
2350 avoided, the results of such a preliminary review would be included in a THP when submitted to CAL
2351 FIRE for filing, review and approval.

2352 Subsection (b) includes a list of information the project proponent must disclose in a THP; including
2353 functional Northern Spotted Owl habitat within and outside the THP area both before and after harvest,
2354 known owl detections, information on owl surveys conducted and results and other information. It
2355 requires a discussion of how functional Northern Spotted Owl habitat will be protected according to
2356 criteria presented in Section 919.10.

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2357 Subsection (c) provides the project proponent the option of obtaining from an RPF a certification to be
2358 included in the THP that Northern Spotted Owls are inferred absent from the THP area and out 1.3 miles
2359 from the THP area based on the results of surveys completed according to the USFWS survey protocol,
2360 (USFWS 2012) and the RPF's personal knowledge and a review of information in the Northern Spotted
2361 Owl database maintained by the Department.

2362 Subsection (d) involves the project proponent proceeding under the provisions of an incidental take
2363 permit issued by USFWS or the Department.

2364 Subsection (e) allows the project proponent to proceed with timber harvest according to the outcome of
2365 a consultation with USFWS. This outcome is memorialized in what is referred to as a "technical
2366 assistance letter" from USFWS.

2367 Subsection (f) allows the project proponent to disclose in the THP the outcome of an SOE's preliminary
2368 review as described under Subsection (a), to demonstrate that any measures to avoid Northern Spotted
2369 Owl take recommended by the SOE have been adopted in the THP and that the proposed timber
2370 operations evaluated by the SOE remain substantially the same in the submitted THP.

2371 Subsection (g) is an option appropriate for THPs where one or more Northern Spotted Owl activity
2372 center has been located within the THP area or within 1.3 miles of its boundary. This option requires the
2373 RPF to determine and document activity center-specific protection measures to be applied under the
2374 THP and that various specified forms and acreages of functional owl habitat (nesting, roosting and
2375 foraging) will be retained post-harvest around each activity center. The minimum acreages to be
2376 retained after harvest of functional nesting, roosting and/or foraging habitat within 500 feet, 500 to
2377 1,000 feet, 0.7 mile and 1.3 miles around each activity center are specified in this subsection.

2378 Section 919.10 [939.10] of the Forest Practice Rules presents the criteria CAL FIRE is to apply to
2379 information provided in the THP and during the THP review period to make a finding as to whether or
2380 not the proposed timber operations will avoid Northern Spotted Owl take in the form of "harass, harm,
2381 pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct", as
2382 defined under Endangered Species Act (ESA). If CAL FIRE concludes take would occur, they must provide
2383 reasons why the determination was made according to criteria presented in section 919.10 [939.10],
2384 what information was used in making the determination, and recommend minimum changes to the
2385 proposed THP to avoid take. According to Forest Practice Rules Section 898.2, Special Conditions
2386 Requiring Disapproval of Plans, CAL FIRE shall disapprove a THP if the THP would cause Northern
2387 Spotted Owl take prohibited by the ESA.

2388 Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were
2389 provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following
2390 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could
2391 inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol,
2392 breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly
2393 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans

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2394 and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol
2395 was revised (USFWS 2012).

2396 When consultations with the USFWS were required, they consisted of a field review of the proposed
2397 THP area, an evaluation of the pre-harvest and predicted post-harvest habitat typing (its suitability for
2398 nesting, roosting, or foraging), the sufficiency of habitat retained post-harvest within 500 feet, 0.7 mile
2399 and 1.3 mile of owl **ACs**, and an evaluation of the adequacy of the surveys that were conducted (i.e.
2400 timing, location, interpretation of results) and their consistency with the USFWS protocol. When
2401 appropriate, the Department designated biologists would evaluate or propose THP-specific habitat and
2402 temporal buffers that differed from standard Forest Practice Rules habitat retention and seasonal
2403 restriction requirements that would be adopted as enforceable conditions of THPs.

Comment [LVD75]: 77.Same comment as on
page 65

2404 In 1991, a curriculum was designed to train private consulting biologists who could conduct the field and
2405 document review portions of a Northern Spotted Owl consultation, although final approval from a
2406 Department designated biologist was still required. University biologists and biological consultants,
2407 along with designated Department Timber Harvest Assessment Program staff helped THP submitters to
2408 evaluate their plans with regard to potential take of Northern Spotted Owls. Workshops helped calibrate
2409 consultants, RPFs and others regarding owl life history, habitat associations, and so forth. Northern
2410 Spotted Owl consultations for most THPs were conducted by the Department designated biologists from
2411 1991 into 1997.

2412 From 1991 through 1997 the Department and to a much lesser extent, CAL FIRE staff processed
2413 Northern Spotted Owl consultations for THPs. Additionally, Department staff participated in the review
2414 of private timber company Habitat Conservation Plans, Spotted Owl Management Plans, and Spotted
2415 Owl Resource Plans. In 1994, Department staff was directed to give Northern Spotted Owl consultations
2416 its highest priority and to set aside a minimum number of days per week to address a consultation
2417 backlog. In this same year, CAL FIRE staff was directed to suspend processing of consultations.

2418 In 1995 the Department established a process for certifying “Private Consulting Biologists” (PCBs) to
2419 fully conduct Northern Spotted Owl consultations, which included approval of a consultation package,
2420 and discontinuing the need for additional approval from a Department designated biologist. However,
2421 Department staff continued to process consultations not prepared or reviewed by PCBs.

2422 Beginning in 1999, Department staff no longer processed THP Northern Spotted Owl consultations and
2423 no longer reviewed the work of private consultant biologists. Reasons for the suspension of processing
2424 included:

- 2425 • Other emerging and compelling forestry sector conservation issues required Department staff’s
2426 attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related
2427 workload).
- 2428 • The Department “Timber Harvest Assessment Program” (later to become the “Timberland
2429 Conservation Planning Program”) budget did not include funding specifically for consultations.
- 2430 • Staffing of USFWS offices with wildlife biologists had increased.

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2431 • The Department felt CAL FIRE and USFWS staff were capable of review, approval, and
2432 assessment of THPs and NTMPs.

2433 • The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.

2434 • The scope, quality and conformance of owl-related information with Forest Practice Rules
2435 requirements appeared to have stabilized after approximately six years of implementation.

2436

2437 Regardless of the suspension in consultation involvement, the Department continued to evaluate THPs
2438 with regard to potential significant impacts to Northern Spotted Owl from timber operations, and as
2439 appropriate reminded THP proponents to comply with Section 3503.5 of the Fish and Game Code. In
2440 addition, the Department continued monitoring compliance with Northern Spotted Owl-related Habitat
2441 Conservation Plan’s conservation measures.

2442 At the time that the Department suspended processing of THP and Nonindustrial Timber Management
2443 Plans (NTMP) consultations (1999), the USFWS technical assistance program began. After nine years of
2444 processing technical assistance requests from applicants, the USFWS notified CAL FIRE in 2008 that
2445 technical assistance requests would have to come directly from CAL FIRE rather than the applicant.
2446 Detailed written guidance and information associated with the analysis process was provided to CAL
2447 FIRE, along with scheduled workshops, to assist in the transition from the USFWS to CAL FIRE (USFWS
2448 2008b). The guidance somewhat deviates from the Forest Practice Rules and included information
2449 needed for Northern Spotted Owl technical assistance, descriptions and appropriate uses for the 1- and
2450 2-year owl survey protocols, owl take avoidance scenarios, and the take avoidance analysis process,
2451 habitat retention criteria within 0.5, 0.7 and 1.3 mile radius from the activity center, and a description of
2452 habitat parameters (i.e., nesting/roosting/foraging habitat) for both the interior and coastal regions.
2453 Since this time, CAL FIRE has been responsible for reviewing the majority of Spotted Owl-affected THPs,
2454 and has assisted applicants and USFWS by assessing technical assistance requests if forwarded to
2455 USFWS.

2456 In 2009, the USFWS developed a white paper, Regulatory and Scientific Basis for the U.S. Fish and
2457 Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in
2458 California’s Northern Interior Region, to scientifically justify why the 2008 guidance deviated from the
2459 Forest Practice Rules (USFWS 2009). Specific criteria within the USFWS guidelines, and how they differ
2460 from the Forest Practice Rules, are discussed in the Timber Harvest section below.

2461 The Department Timber Harvest Assessment Program was eliminated in late 2010. From a high of 33
2462 staff members state-wide in 2007, fewer than eight remained engaged in forestry environmental review
2463 and permitting in 2011. The remaining positions were assigned to other programs in the Department,
2464 and in some cases were still involved in a range of forestry-sector work (e.g., lake or streambed
2465 alteration agreements, natural community conservation plans, sustained yield plans and limited THP
2466 environmental review).

2467 In 2013, a new Department “Timberland Conservation Planning Program” (TCP) was established through
2468 a stable funding source and authorities mandated pursuant to Assembly Bill 1492 (2012), to ultimately
2469 increase staff to 41 in Department Headquarters and in four Department Regions. Today, TCP Staff

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members participate in THP review, process lake or streambed alteration agreements, complete species consultations (including “pre-consultations”) for “sensitive species” and those that are listed or candidates for listing pursuant to CESA, review forest habitat restoration grant proposal, and other activities. In addition, as required by Assembly Bill 1492, TCP staff are mandated to and will soon embark on inspections of approved and completed THPs and compliance and effectiveness monitoring. Department staff members selectively review Northern Spotted Owl-related information disclosed in THPs as part of routine THP environmental review; however, with the broad suite of other mandated THP review-related responsibilities, the TCP’s allocated staffing and resources are not adequate to allow staff to engage in Northern Spotted Owl consultations at the level and in ways they did in the 1990s.

Timber Harvest Management

Timber Harvest Plans

As noted previously, a THP is a document that outlines the level and type of proposed timber harvest, and details steps to be taken to prevent damage to the environment, including measures to avoid take of Northern Spotted Owl. Landowners prepare THPs following the provisions of the Forest Practice Rules, and select options for which to follow (Section 919.9 [939.9], subsections (a) through (g)). The purpose of these options is to avoid take of Northern Spotted Owl.

After reviewing all THPs within the Northern Spotted Owl range submitted to CAL FIRE in 2013, it was apparent that Forest Practice Rules section 919.9[939.9], subsections e and g (hereafter referred to as Option (e) and (g)), were the most frequently used among THPs submitted, and thus, have the greatest potential to impact owl habitat. Other THPs applied Section 919.9/939.9, subsections a, b, and d. Therefore, for THPs submitted in 2013 utilizing Option (e) and (g), we assessed each THP, available through CAL FIRE, for consistency and appropriate application regarding impact avoidance to the Northern Spotted Owl.

For the THPs assessed, proposed silvicultural prescription method and acreage was summarized by county. Silvicultural prescription methods are defined in the Forest Practice Rules, and are included in Appendix 1. In addition, for each THP utilizing Option (e) and (g), the potential impact of proposed harvest to activity centers in each option was assessed as well. Due to the different habitat retention guidance for interior and coastal THPs, the assessment conducted for interior counties were conducted only for THPs associated with activity centers within 1.3 miles of the proposed project, and the assessment for coastal counties included only THPs that were associated with activity centers within 0.7 miles.

Within the range of the Northern Spotted Owl in California, a total of 175 THPs were submitted to CAL FIRE in 2013 from ten counties (Del Norte, Humboldt, Mendocino, Shasta, Siskiyou, Sonoma, Napa, Marin, Tehama, and Trinity counties). Of these, 115 THPs were associated with owl activity centers, encompassing approximately 69,226 acres of proposed harvest on private timberland. Figures 12 and 13 summarize number and percent of THPs submitted from each county on the interior and coastal

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2508 regions. Of the 115 THPs, 93 were coastal THPs associated with owl activity centers within 0.7 mile, and
2509 22 were interior THPs associated with owl activity centers within 1.3 miles.

2510 Of the 115 THPs associated with owl activity centers, a total of 66 utilized Option (e) (60 coastal and six
2511 interior), and 9 utilized Option (g) (two coastal and seven interior) in 2013. Silvicultural prescription
2512 methods and associated acres of proposed harvest from the 66 THPs that applied Option (e) in 2013 are
2513 summarized in Figure 14. Silvicultural prescription methods and associated acres of proposed harvest
2514 from the nine THPs that applied Option (g) in 2013 are summarized in Figure 15. Variable Retention
2515 prescription was the most utilized method for THPs using Option (e), with nearly 28,000 acres of
2516 proposed harvest. Alternative, Clear Cut, and Shelterwood prescriptions were the most utilized method
2517 for THPs using Option (g), with 1,413, 714, and 657 acres of proposed harvest, respectively. The number
2518 of THPs and the cumulative proposed acres for THPs utilizing Option (e) far surpassed those using
2519 Option (g).

2520 Proposed silvicultural prescription methods and harvest amounts within the interior and coastal THPs
2521 varied significantly. The dominant methods and acreages for 2013 interior and coastal THPs that used
2522 Option (e) and Option (g) and are associated with activity centers are summarized in Table 12. In the
2523 interior, the Alternative method was proposed more than any other method, covering 9,798 acres
2524 within 1.3 miles of an activity center, and covered more than half of the total acreage. When the
2525 Alternative method is used, the plan must include a description of which silvicultural method is most
2526 nearly appropriate or feasible, and must also describe how the Alternative method differs from the most
2527 similar method. For plans using the Alternative method in the interior, the majority of THPs identify
2528 Clear Cut as the silvicultural method most similar to the Alternative method used. Alternative method
2529 units typically include a habitat retention area, which can range from 2-10% of the harvest unit. Habitat
2530 retention areas usually include hardwoods and/or cavity trees to promote use by wildlife species. On the
2531 coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more
2532 area than all other methods combined.

2533 **Table 12.** Silvicultural prescription methods proposed within 1.3 miles of an activity center in interior THPs and
2534 within 0.7 miles of an activity center in coastal THPs in 2013.

<u>13 THPs from</u>		<u>62 THPs from</u>	
<u>Interior Counties</u>	<u>Acres</u>	<u>Coastal Counties</u>	<u>Acres</u>
Alternative	9,798	Variable Retention	28,144
Group Selection	2,389	Selection	5,227
Clear Cut	2,257	Group Selection	4,314
Shelterwood Removal	1,574	Transition	3,470
Commercial Thinning	1,335	Seed Tree Removal	1,645
No Harvest Areas	1,015	Clear Cut	1,404
		Rehabilitation	990

2535

2536 To better understand the level of impact of proposed harvest and retention to owl activity centers, each
2537 THP utilizing Option (e) and Option (g) in 2013 within the interior and coastal region was assessed
2538 further. For 13 interior THPs (six using Option (e) and seven using Option (g)), habitat retention and

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2539 harvest were assessed at two scales: within 0.5 miles and between 0.5 and 1.3 miles of an activity
2540 center. For 62 coastal THPs (60 using Option (e) and two using Option (g)), habitat retention and harvest
2541 was only assessed within 0.7 miles of an activity center.

2542 It is important to note that the Forest Practice Rules and USFWS guidance regarding habitat retention
2543 vary. As mentioned previously, the Forest Practice Rules outline appropriate retention guidelines to be
2544 established within THPs submitted under Option (g). In 2009, the USFWS made recommendations for
2545 habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat
2546 from Forest Practice Rules guidelines.

2547 Forest Practice Rules guidelines under Option (g) are:

- 2548 • Nesting habitat must be retained within 500 feet of the activity center
- 2549 • Roosting habitat must be retained within 500-1000 feet of the activity center
- 2550 • 500 acres of owl habitat must be provided within 0.7 mile radius of the activity center
- 2551 • 1336 acres of owl habitat must be provided within 1.3 mile radius of the activity center

2552 The USFWS (2009) recommendations are:

- 2553 • No timber removal within 1000 feet of activity center, either inside of outside of the breeding
2554 season
- 2555 • At least 250 acres of nesting/roosting habitat and at least 150 acres of foraging habitat must be
2556 retained within 0.5 mile radius of the activity center
- 2557 • Between 0.5-1.3 mile radius of the activity center at least 655 acres of foraging habitat and 280
2558 acres of low quality foraging habitat must be retained

2559 As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern
2560 Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option
2561 (e) in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2562 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center
2563 once timber harvesting had been completed. For each of the six interior THPs, four primary habitat
2564 types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting
2565 as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option
2566 (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a
2567 given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-
2568 habitat.

2569 Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for
2570 THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior,
2571 and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the
2572 interior (2,117 acres within 0.5 miles and 9,776 acres within 0.5-1.3 miles). On the coast, foraging and
2573 nesting/roosting were retained at relatively similar levels within 0.7 miles (52,817 acres of foraging;
2574 47,344 acres of nesting and roosting).

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As noted previously, seven interior THPs and two coastal THPs associated with a total of 14 Northern Spotted Owl activity centers (8 interior activity centers, and 6 coastal activity centers) utilized Option (g) in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center once timber harvesting had been completed. For each of the seven interior THPs, habitat types were assessed: low quality foraging, foraging, and nesting and roosting. For the two coastal THPs that utilized Option (g) a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given THP. For these two THPs, three primary habitat types were assessed: foraging, nesting/roosting, and non-habitat.

Table 13. Proposed acres of habitat retention near activity centers from THPs utilizing Option (e) in 2013. Totals include retention acres for 6 interior THPs and 60 coastal THPs (66 THPs total). Owl habitat is defined as low quality foraging (LQF), foraging (F), nesting/roosting (NR), high quality nesting/roosting (HQNR), and non-habitat (NH).

	<u>6 Interior THPs associated with 14 activity centers, Option (e)</u>		<u>60 Coastal THPs associated with 132 activity centers, Option (e)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	770	4,702	n/a
F	2,117	9,776	52,817
NR	1,487	6,324	47,344
HQNR	1,649	2,940	n/a
NH	n/a	n/a	31,222

Comment [LVD76]: 78.Same comment as on page 65

Table 14 summarizes proposed acres of owl habitat retention within the interior and coastal regions for THPs utilizing Option (g). Total acreages presented are cumulative acres for 7 THPs within the interior, and 2 THPs within the coast. Within the interior, nesting/roosting and foraging habitat were similarly proposed for retention, with Low Quality Foraging the least common habitat type retained. Within the coast, nesting/roosting habitats were retained more than either foraging or non-habitat.

Table 14. Proposed acres of habitat retention near activity centers from THPs utilizing Option (g) in 2013. Totals include retention acres for 7 interior THPs and 2 coastal THPs (9 THPs total). Owl habitat is defined as low quality foraging (LQF), foraging (F), nesting/roosting (NR), and non-habitat (NH).

	<u>7 Interior THPs associated with 8 activity centers, Option (g)</u>		<u>2 Coastal THPs associated with 6 activity centers, Option (g)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	612	3,004	n/a
F	1,032	3,171	1,548
NR	1,388	3,879	2,763
NH	n/a	n/a	1,597

Comment [LVD77]: 79.Same comment as on page 65

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Over time, activity centers may be cumulatively impacted by timber management activities. Through the use of Option (e) and Option (g), habitat retention and harvest for interior THPs from 2013 were typically assessed within 0.5 miles and between 0.5 and 1.3 miles of an activity center; whereas for coastal THPs from 2013 habitat retention and harvest were assessed primarily within 0.7 miles of an activity center. The 0.5 mile and 0.7 mile radius around activity centers is meant to capture the core habitat use of Spotted Owls within their home range, whereas the 1.3 mile radius is meant to capture the broader home range. Therefore timber harvest within these radii has a potential to impact quality and extent of owl habitat, and consequently, owl fitness. As discussed previously, to mediate this loss the Forest Practice Rules set limits on the amount and type of habitat that may be harvested within certain radii. Since timber growth is slow, and consequently, regrowth of owl habitat is slow, it is important to understand the cumulative impact to activity centers over time.

To consider the risk of habitat removal to individual activity centers, the amount of habitat proposed for harvest was calculated for activity centers addressed in THPs utilizing Option (e) and Option (g) over various periods in time between 1986 and 2013 (Tables 15 and 16). The activity centers evaluated were selected from those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by evaluating all THPs associated with these activity centers in past harvest history. The sample selected for evaluation did not include all of the activity centers associated with THPs in 2013, only a subset. Activity centers were chosen from all counties associated to provide results on a broad scale. An approximately even number of activity centers were chosen from each county. At the proposed levels of harvest noted in the THPs, it is apparent that some activity centers have experienced extensive habitat removal or modification over time. Of the 17 activity centers evaluated in the interior, six activity centers have experienced greater than 2,000 acres timber harvest cumulatively over time within the 1.3 mile radius (~3,400 acres) home range, and six activity centers have experienced greater than 250 acres timber harvest within the 0.5 mile radius (~500 acres) core range. Of the 14 activity centers evaluated on the coast, six activity centers experienced harvest of over 500 acres, cumulatively, within the 0.7 mile radius (~985 acres) core range, with two of these over 1,000 acres. Appendix 3 includes bar graphs for each activity center within the coast and interior, and depicts level of harvest within 0.5, 0.7, and 1.3 mile radii from the activity center.

It is reasonable to assume that high levels of harvest, such as shown for some activity centers in Table 15 and 16, can negatively impact Northern Spotted Owls. Although no study has been conducted specifically linking the amount of harvest within the 0.5, 0.7, and 1.3 mile radius of an activity center to impacts on owl fitness (e.g., reproductive rate, survival, etc.), [Green Diamond has evaluated the impact of timber harvest with a 0.5 mile radius of an activity center or nest site \(Diller et al. 2010\)](#). Several research studies have demonstrated a link between owl fitness and amount of habitat, structural characteristics, and spatial configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007, [Diller et al. 2010](#)). These studies are discussed in more depth above in the Habitat Requirements section (Habitat Effects on Survival and Reproduction) and below in the Habitat Loss and Degradation threat section of this document. Through comparison of Northern Spotted Owl territory loss on private and federal lands, the USFWS (2009) suggests that the Forest Practice Rules have not been entirely effective in preventing cumulative loss of important owl habitat surrounding activity

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2639 centers associated with repeated harvest. Details regarding the USFWS analysis can be found in the
2640 Regulatory Mechanisms Consideration section of this document.

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2642 **Table 15.** Proposed timber harvest (in acres) within interior THPs utilizing Option (e) and Option (g) over time
2643 (range 1997-2013), showing level of harvest within 0.5 miles and between 0.5-1.3 miles of activity centers. The
2644 activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were
2645 evaluated over time by evaluating all THPs associated with these activity centers since 1997.

Activity Center	Range of Harvest Years	Interior, Option (e) Acres harvested		Interior, Option (g) Acres harvested	
		0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)	0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)
SIS0492	2004-2013	0	915	x	x
SIS0554	1998-2004	102	589	x	x
TEH0030	1998-2013	381	2,554	x	x
TEH0037	1998-2013	379	2,221	x	x
TEH0038	1998-2013	151	1,002	x	x
TEH0072	1998-2013	476	1,954	x	x
TEH0075	1997-2004	277	2,530	x	x
TEH0087	1998-2013	291	2,137	x	x
TEH0101	1997-2013	168	2,113	x	x
TEH0114	2002	0	8	x	x
TEH0117	2006-2013	37	1,123	x	x
SHA0024	2003-2005	x	x	41	239
SHA0037	1998-2013	x	x	0	426
SHA0106	2000-2013	x	x	21	160
SIS0319	1997-2013	x	x	31	1,505
TRI0169	2000-2013	x	x	0	118
TRI0316	1997-2013	x	x	251	495

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Table 16. Proposed timber harvest (in acres) within coastal THPs utilizing Option (e) and Option (g) over time (range 1986-2013), showing level of harvest within 0.7 miles of activity centers. The activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by evaluating all THPs associated with these activity centers since 1986.

Activity Center	Range of Harvest Years	Coast, Option (e) Acres harvested within 0.7 mile radius (~985 acre core area)	Coast, Option (g) Acres harvested within 0.7 mile radius (~985 acre core area)
HUM0058	2011-2013	30	x
HUM0400	1990-2013	510	x
HUM0622	1993-2013	798	x
HUM0791	1999-2013	270	x
HUM0986	1997-2013	162	x
MEN0146	1994-2013	1,180	x
MEN0309	1987-2013	565	x
MEN0370	1992-2010	413	x
HUM0097	1996-2013	x	345
HUM0098	2004-2005	x	67
HUM0308	1996-2013	x	226
HUM0442	2004-2013	x	227
MEN0082	1986-2013	x	1,316
MEN0114	1987-2013	x	829

Nonindustrial Timber Management Plans

In 1989, the Legislature added language to the Forest Practice Act creating provisions to include Nonindustrial Timber Management Plans (NTMPs) to promote long term management and planning on forest ownerships of 2,500 acres or less (Pub. Resources Code §4593 et seq.). Private forestlands are generally classified into non-industrial and industrial ownerships based on acreage and association with industrial uses. Non-industrial private forest (NIPF) owners typically have less than 5,000 acres of forestland and do not own a mill. Of the private forestlands in California, NIPF owners collectively hold about 3.2 million acres (41%), with the balance being held by industrial forest landowners.

The NTMP allows smaller NIPF timberland owners to prepare a long-term management plan that reduces regulatory time and expense by providing an alternative to submitting individual THPs prior to harvest. Landowners agree to manage their forests through uneven-aged management and long-term sustained yield, in exchange for a higher degree of regulatory surety. “Sustained yield” means the yield of commercial wood that an area of commercial timberland can produce continuously at a given intensity of management consistent with required environmental protection and which is professionally planned to achieve over time a balance between growth and removal (Pub. Resources Code, § 4593.2, subd. (d); Forest Practice Rules, § 895.1). Timberland owners operating under an NTMP are also protected under provisions of Public Resources Code section §4593, which offers landowners exemption

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2671 from applying subsequent rule changes to Forest Practice Rules to their project; however, this does not
2672 mean that a NTMP will never be subject to new laws or regulations.

2673 Public Resources Code section §4594 subdivision (h) requires RPFs to submit a Notice of Operations
2674 (NTO) prior to harvest that specifies that the NTMP will implement best management practices for the
2675 protection of water, soil stability, forest productivity, and wildlife, as required by the current rules of the
2676 Board, or is consistent with the original plan and will not result in any significant degradation to the
2677 beneficial uses of water, soil stability, forest productivity or wildlife. Required applications and
2678 administration of NTMPs are detailed in the Forest Practice Rules commencing with section 1090.
2679 Landowners submitting proposed NTO's subsequent to requirements of Forest Practice Rules, section
2680 919.9 [939.9] subdivisions (a) through (g), are expected to either contain specific measures that fulfill
2681 these requirements or best management practices equivalent to such provisions. These options have
2682 resulted in variable and diverse Northern Spotted Owl protection measures within NTMPs; however,
2683 Options (e) and (g) are the most commonly used options. As stated previously, Option (e) allows
2684 landowners to submit a technical assistance letter to the USFWS for approval. Under Option (g), the
2685 landowner must supply the location of activity centers located within the plan boundary or within 1.3
2686 miles of the boundary.

2687 NTMP prevalence has grown steadily since its inception. Table 17 summarizes the approaches
2688 landowners took to protect comply with Forest Practice Rules in avoiding take of Northern Spotted Owl
2689 through NTMPs over time, including numbers of NTMPs within 1.3 miles of an activity center and the
2690 those NTMPs utilizing Option (e) and Option (g) over 1991-2014 for the interior forests, and 2005-2014
2691 for the coastal forests. A total of 157 NTMPs were evaluated within the range of the Northern Spotted
2692 Owl: 35 from the interior portion of the range that were submitted from 1991-2014, and 122 from the
2693 coastal portion of the range that were submitted from 2005-2014. It should be noted that the majority
2694 of NTMPs on the coast were submitted prior to 2005 (418 NTMPs in 1991-2004 versus 122 NTMPs in
2695 2005-2014). However time did not allow full review of that time period for coastal NTMPs. Of the 157
2696 NTMPs evaluated, 115 are within 1.3 miles an owl activity center. Option (e) and Option (g) were applied
2697 in 114 and 14 NTMPs, respectively.

2698 During 1991 through 2014 35 NTMPs have been approved for landowners in the interior portion of the
2699 Northern Spotted Owl range (Siskiyou, Trinity, Shasta, and Tehama counties), with 10 plans utilizing
2700 Option (e), 10 plans utilizing Option (g) and the remainder using another option. Of the 35 NTMPs, 19
2701 (54%) were associated with at least one Northern Spotted Owl activity center within 1.3 miles of the
2702 plan boundary. The coastal portion of the range (Humboldt, Mendocino, Sonoma, Lake, and Napa
2703 counties) saw substantially more NTMPs within a shorter time frame. From 2005 to 2014, 122 NTMPs
2704 were submitted and approved. Although Del Norte County is part of the owl's range, no NTMPs were
2705 submitted during this time frame. Of the 122 NTMPs evaluated, 96 (78%) were associated with at least
2706 one activity center within 1.3 miles of the plan boundary. Of these, the majority (104 NTMPs) utilized
2707 Option (e) (i.e., USFWS technical assistance letter); therefore, the USFWS has been instrumental in
2708 providing consultation and guidance to NTMPs submitters as it relates to protection measures for
2709 Northern Spotted Owl and their habitat.

Comment [A78]: 80. Note to external reviewers:

81. We are currently working to get all coastal NTMPs (1991-2014) summarized in the table. This will be included in the next version. In addition, number of ACs associated with the NTMPs will be added for all counties.

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2710 **Table 17.** Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years
2711 2005-2014 for plans in Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	NTMPs in NSO Range	NTMPs within 1.3 miles of NSO	NTMPs that implemented 939.9 (e)	NTMPs that implemented 939.9 (g)	NTMPs that used other options
<i>Interior Counties 1991-2014</i>					
Siskiyou	16	13	6	7	1
Trinity	6	3	2	2	0
Shasta	11	3	2	1	0
Tehama	2	0	0	0	2
Interior Subtotal	35	19	10	10	3
<i>Coastal Counties 2005-2014</i>					
Humboldt	41	40	38	2	0
Mendocino	58	45	43	2	0
Sonoma	19	9	19	0	0
Lake	3	1	3	0	0
Napa	1	1	1	0	0
Coastal Subtotal	122	96	104	4	0
Total	157	115	114	14	3

2712

2713

2714 For NTMPs in Siskiyou, Trinity, and Shasta counties measures were analyzed for proposed silvicultural
2715 prescription methods for years 1991-2014, and for years 2005-2014 in Humboldt, Mendocino, Sonoma,
2716 Lake, and Napa counties (Table 18). Only NTMPs that occurred within 1.3 miles of a Northern Spotted
2717 Owl activity center were included in this analysis; therefore, Tehama NTMPs have been excluded.
2718 Silvicultural prescription methods noted in Table 18 are those most often proposed within the NTMPs
2719 analyzed. Other prescriptions proposed but not included in Table 18 include Road Right of Way,
2720 Sanitation Salvage, Special Treatment, Fuel break, and Variable Retention, and is inclusive of 747
2721 cumulative acres.

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2722 **Table 18.** Acres proposed for harvest under NTMPs within 1.3 miles of a Northern Spotted Owl activity center for
2723 various silvicultural prescriptions. NTMPs are from years 1991-2014 for Siskiyou, Trinity, and Shasta counties, and
2724 2005-2014 for Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	Selection	Group Selection	Uneven-aged	Commercial Thinning	Non-Timberland Area	Transition	Rehabilitation of under-stocked
<i>Interior Counties</i> 1991-2014							
Siskiyou	2597	60	1127	251	22	251	251
Trinity	2783	237	653	0	0	0	0
Shasta	1609	1036	2276	273	463	0	0
Interior Subtotal	6989	1333	4056	524	485	251	251
<i>Coastal Counties</i> 2005-2014							
Humboldt	2322	6139	0	35	424	1101	1658
Mendocino	4561	1926	0	0	419	975	71
Sonoma	547	4603	0	0	127	245	246
Lake	45	587	0	0	0	0	0
Napa	0	683	0	0	17	0	0
Napa-Lake	1858	0	0	0	0	0	0
Coastal Subtotal	9333	13938	0	35	987	2321	1975
Total	16322	15271	4056	559	1472	2572	2226

2725

2726 Of the NTMPs included in this analysis, a total of 42,478 acres were proposed for harvest within 1.3
2727 miles of an activity center. Selection, Group Selection, and Uneven-aged silvicultural methods are the
2728 most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through
2729 the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection,
2730 Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Most plans that
2731 used the Uneven-aged silvicultural method did not delineate acres that would fall under each category.
2732 For NTMPs submitted on the interior from 1991-2014, Selection, Group Selection, and Uneven-aged
2733 totaled 6,989, 1,333, and 4,056 acres, respectively. For NTMP submitted from 2005-2014 on the coast,
2734 Selection and Group Selection totaled 9,333 and 13,938 acres, respectively. Cumulatively, these more
2735 common silvicultural methods equates to 29% (12379/42478) of the total acres proposed for harvest

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2736 under interior NTMPs analyzed, and 55% (23271/42478) of the total acres proposed for harvest under
2737 coastal NTMPs analyzed.

2738 The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl
2739 habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear
2740 that some information was not available to the reviewer due to the nature of the older NTMP
2741 narratives, limited public information, and subsequent amendment submissions. There is simply no
2742 effective way to track this information in an analysis going back in time. Though Selection and Group
2743 Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range,
2744 we can infer that owl habitat is retained to some extent; however, we could not determine the type or
2745 quality of habitat retained. For instance, high quality nesting and roosting habitat may be harvested
2746 more frequently, thereby reducing owl fitness.

2747 Spotted Owl Management Plans

2748
2749 A Spotted Owl Management Plan (SOMP) details measures to avoid take of Northern Spotted Owl as a
2750 result of timber harvest operations on privately owned land. SOMP are developed cooperatively
2751 between USFWS and a private land owner, and can be used to streamline the review of THPs. SOMP
2752 follow the procedures in Forest Practice Rules section 939.9 subdivision (e) and include:

- 2753 • a description of the area covered
2754 • protection measures for breeding or nesting Northern Spotted Owls
2755 • habitat definitions, and
2756 • habitat quality and quantity retention requirements

2757
2758 SOMP are contain expiration dates upon which USFWS and land owners meet to review and revise the
2759 document as necessary; however, incorporation of new scientific information may occur at any time
2760 during the lifetime of the SOMP. SOMP differ from the standard no-take measures provided in the
2761 Forest Practice Rules in that they utilize site-specific information in conjunction with research to develop
2762 strategies to avoid take over a period of years. The most notable difference between SOMP no-take
2763 requirements and those in the standard Forest Practice Rules section is the primarily survey area
2764 required and possibly habitat required post-harvest. Survey areas may be reduced as a result of local
2765 information collected over a number of years. Post-harvest habitat requirements may also be greatly
2766 reduced or increased based on site specific local information.

2767 Three SOMP are currently being used in the THP process in California. Two of these were reviewed for
2768 this assessment by the Department, totaling 175,700 acres in Siskiyou, Trinity and Shasta Counties. The
2769 Department never received a copy of the third SOMP, located in Mendocino County; therefore we are
2770 unable to discuss it here. Both documents reviewed included the elements listed above, and were
2771 developed with the USFWS considering site-specific information for those properties. Within the SOMP
2772 reviewed, suitable habitat definitions were developed specifically for the ownership(s) utilizing the
2773 SOMP. These habitat definitions are developed using information from the property and may be
2774 different from those suitable habitat definitions in survey protocols or other rules or regulations.

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2775 | It is not known if the long-term use of SOMPs on private lands in California is limiting-affecting Northern
2776 Spotted Owl populations, but all operations conducted under a SOMP occur within the known range of
2777 Northern Spotted Owl and usually within suitable owl habitat. More information is needed to fully
2778 understand the effects of SOMPs on Northern Spotted Owls.

Comment [LVD79]: 82. It would be very unlikely that any management action that only occurs on a tiny fraction of all the potential owl habitat in CA could be limiting the population.

2779 Spotted Owl Resource Plans

2780

2781 A Spotted Owl Resource Plan (SORP) is intended to offer landowners submitting THPs a programmatic
2782 approach to avoid take of Northern Spotted Owl. SORPs are addressed in Forest Practice Rules section
2783 919.9 subdivision (a), and is defined as, "...an approach to preventing a taking of the northern Spotted
2784 Owl while conducting timber operations [,]" and "...necessarily involves more than one timber harvest
2785 plan." SORPs do not differ significantly from the required habitat retention guidelines found in the
2786 Forest Practice Rules section 919.9 subdivision (g), and mainly provide a programmatic method for
2787 Northern Spotted Owl protection. A description of the area covered, protection measures for breeding
2788 or nesting Northern Spotted Owls, habitat definitions, survey areas and habitat quality and quantity
2789 retention requirements are all provided within a SORP. A SORP may be submitted to CAL FIRE for
2790 preliminary review, and once approved, can be attached to individual THPs submitted by a landowner
2791 under Forest Practice Rules section 919.9 subdivision (a). The THP is reviewed by the Department, but
2792 not necessarily the SORP.

2793 A total of three SORPs have been approved and are being utilized in the THP process in California, and a
2794 fourth SORP is being prepared. The three approved SORPs cover a total of 358,202 acres. All three
2795 SORPs use a combination of no-take language from Forest Practice Rules section 939.9, along with site-
2796 specific information to develop no-take requirements. No specific habitat definitions were developed for
2797 SORPs, and thus, either standard habitat definitions from the Forest Practice Rules or standard habitat
2798 definitions from the USFWS are used within the plans. The site-specific information is used mostly for
2799 protocol survey areas and noise disturbance buffer distances, and is usually developed from historical
2800 survey records and independent noise level studies.

2801 | It is not known if the long-term use of SORPs on private lands in California is limiting-affecting Northern
2802 Spotted Owl populations, but all operations conducted under a SORP occur within the known range of
2803 Northern Spotted Owl usually are within suitable owl habitat. More information may be needed to fully
2804 understand the effects of SORPs on Northern Spotted Owls.

2805 Habitat Conservation Plans

2806

2807 Under Section 10(a) of the ESA incidental take, defined as take that is incidental to and not the purpose
2808 of the carrying out of an otherwise lawful activity, may be authorized for federally threatened and
2809 endangered species via a Habitat Conservation Plan (HCP). California's Natural Community Conservation
2810 Planning Act of 1991 takes a broader approach than either CESA or ESA. A Natural Community
2811 Conservation Plan (NCCP) identifies and provides for the protection of plants, animals, and their
2812 habitats, while allowing compatible and appropriate economic activity. HCPs and NCCPs are both long-
2813 term landscape level conservation plans that allow harvest of Northern Spotted Owl habitat, which
2814 could result in a specified level of incidental take of owls within the plan area. Generally, these plans

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require historical and occupied Northern Spotted Owl activity centers to be monitored to ensure a healthy and stable population, suitable foraging, and nesting habitat to be maintained or created, and activities to be adjusted accordingly using an adaptive management approach.

Five HCPs that include Northern Spotted Owl as a covered species have been issued in California (Table 19). One plan, on Mendocino Redwood Company land, is in the development process and will be a combination HCP and NCCP. Each of these plans is described in more detail below.

Table 19. Current and planned HCPs/NCCPs in California that include Northern Spotted Owl as a covered species.

Plan Title	Location	Date Permit Issued	Term
Green Diamond Resource Company California Timberlands & Northern Spotted Owl HCP	Humboldt, Del Norte, Trinity Counties	09/17/1992 new HCP near completion	30 years – new plan will be 50 years
Regali Estates HCP	Humboldt County	08/30/1995	20 years
Humboldt Redwood Company HCP	Humboldt County	03/01/1999	50 years
Terra Springs LLC HCP	Napa County	03/03/2004	30 years
Fruit Growers Supply Company HCP	Siskiyou, Shasta, and Trinity Counties	11/27/2012*	50 years
Mendocino Redwood Company HCP/NCCP	Mendocino County	No permits issued	80 years

*A recent court decision in April 2015 determined the Fruit Growers Supply Company HCP to be invalid.

Comment [LVD80]: 83. All of Green Diamond's ownership in Trinity County has been sold.

Green Diamond Resource Company Northern Spotted Owl HCP

Green Diamond Resource Company (GDRC) inherited the existing Northern Spotted Owl HCP when they acquired Simpson Timber Company (STC 1992). The HCP has a 30-year term, which expires September 17, 2022, and calls for a full review at the end of 10 years of implementation. GDRC currently owns approximately 383,100 acres of forestland in California within the Northern Spotted Owl range, mostly located within Del Norte and Humboldt counties, with only small portions in Mendocino and Trinity counties, and is located within the California Coast Province. Of the 383,100 acres, 86% are conifer forests comprising two dominant species, coastal redwood, and Douglas-fir. Since most of the conifer forests have been harvested over the last several decades, second-growth makes up all but a small fraction. Residual areas of old-growth forests (logged in the early 1940s and 1960s) make up less than 3%, and are concentrated in the more inland portions of GDRC ownership. Forested areas never logged (virgin old-growth) are scattered throughout the land ownership and consist of 150 acres of redwood and 300 acres of Douglas-fir, comprising less than 2% of GDRC land. Hardwood forests (oak species, madrone, alder) comprise 8%, and non-forest (grassland, wetland, rock and river bars) 6%. As of 1991, just prior to issuance of the HCP, 146 ACs were known to occur on GDRC lands. Density of owls was much higher in the southern portions of land ownership, than the northern portion (1.2 owls/mi² and 0.32 owls/mi², respectively).

Comment [LVD81]: 84. Not really a case of GDRC acquiring STC. It was just a name change within the same company.

Comment [LVD82]: 85. Check to get the latest figures.

Comment [LVD83]: 86. These areas have been sold

Comment [LVD84]: 87. Same comment as on page 65

During development, the HCP prepared a 30-year age-class forecast model to determine how much habitat would be available to owls over time, and developed a predictive habitat (nesting mosaic) model to estimate nesting habitat on the GDRC land ownership. The age-class forecast covered 1991 through

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2845 2021, and assumed timber harvest would occur at an annual rate of 3,000-6,000 acres. Results indicated
2846 that second-growth stands in the 46+ year age-class would more than double, the 31-45 year age-class
2847 would increase by approximately 50,000 acres in first 10 years then return to 1991 levels, and the 8-30
2848 year age-class would generally decrease over time. The nesting mosaic model was designed to
2849 determine the mosaics of habitat types associated with owl activity centers and utilized the 1991 cover
2850 types and age-classes. Results initially indicated 158,477 acres of GDRC land fit the nesting mosaic
2851 profile, with the number of ACs in 2021 would be roughly the same as the 1991 level.

Comment [LVD85]: 88.Same comment as on page 65

2852 The level of take (via owl displacement and habitat modification) was estimated at 3 pairs per year over
2853 first 10 years through direct habitat modification (habitat removal within owl sites), and 2 owls per year
2854 over first 10 years via indirect displacement (habitat removal in adjacent stands to owl sites).
2855 Conservation measures were developed to avoid or minimize the likelihood of take, and include:

- 2856 • Habitat management and nest site protection. Implementation will protect nest sites during
2857 breeding and fledging periods, maintain foraging, roosting and nesting habitat, and accelerate
2858 growth of replacement stands. Stands to be harvested March through August will be surveyed
2859 for Spotted Owls before entering area, as well as a 1,000 ft buffer around the area planned for
2860 harvest. Just prior to harvest, up to three more surveys will be conducted. Nest trees will be
2861 marked and no timber harvest is to be conducted within a 0.25 mile radius until after young
2862 have fledged or the nest fails, and a 500 ft radius after fledging until the young disperse.
2863 Valuable land resources for Spotted Owls will be retained on the landscape, such as
2864 hardwood/conifer patches, habitat along watercourses, snags, standing live culls, and brush.
- 2865 • Development of a research program. A research program consists of ongoing owl surveys,
2866 banding owls, monitoring reproductive success, identifying important nest site attributes, and
2867 assessing abundance and distribution.
- 2868 • Development of habitat area to be set-aside. Thirty-nine habitat set-asides were identified in
2869 which timber harvest would not occur. The total acreage of these set asides is 13,242.5 acres
2870 and, as of HCP issuance, 39 owl sites. A 0.25 mile or 500 foot buffers are placed around sites to
2871 ensure timber removal or other associated harvest activities adjacent to set-asides to not impact
2872 owl sites within. Set-asides were monitored annually.
- 2873 • Staff training. A program was developed to properly train GDRC employees and contractors to
2874 monitor owls and collect data.

2875
2876 The trigger for any course correction required during the HCP term will be if the reproductive rate falls
2877 below the rate of the Willow Creek Study Area (WCSA) for three consecutive years. The WCSA was a
2878 good comparison at the time due to its proximity to GDRC and its unique long-term Spotted Owl
2879 dataset. Since 1993, comparisons of reproductive rates at GDRC and WCSA show that the study area
2880 with higher annual reproductive rate often shifts between the two areas. There have not been three
2881 consecutive years with statistically significant results showing the reproductive rate at GDRC falling
2882 below that at WCSA (GDRC 2015).

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2883 | ~~According to Diller et al. (2012), GDRC’s original 1992 HCP was developed when comparatively little was~~
2884 ~~happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the~~
2885 ~~understanding of suitable owl habitat was limited.~~ In 2006, GDRC submitted an application to the
2886 USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was
2887 issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes
2888 the Project, requires the Applicant to comply with terms of the amended BO and its associated
2889 incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified
2890 the Department that the BO was issued and requested that the Department issue a consistency
2891 determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1.
2892 In January 2014, the Department found that BO, its related ITS and ITP, and the HCP were consistent
2893 with CESA and meet the conditions set forth in Fish and Game Code section 2081 for authorizing
2894 incidental take of CESA-listed species (CDFW 2014a).

2895 The Department found that the mitigation measures identified in the amended ITP and HCP will
2896 minimize and fully mitigate the impacts of take and the continued existence of Northern Spotted Owl
2897 will not be compromised. Measures in the amended versions include, but are not limited to:

- 2898 • Maintaining a 20,310 acres “Special Management Area” in Upper Mad River area where Spotted
2899 Owls may not be taken.
- 2900 • Survey for Spotted Owls in each area where timber harvest is planned, and delay harvest of nest
2901 site and primary activity centers in after the breeding season.
- 2902 • Maintain records of surveys and actual take and notify the USFWS events such as direct harm to
2903 owls, catastrophic events that destroy owl sites, shifts in distribution, accidental death, or injury
2904 of owls, and the finding of dead or injured owls.
- 2905 • Continue gathering data on owl behavior and habitat needs, and update GIS database regularly.
- 2906 • Establish 39 set-asides that represent 13, 252 acres in which timber harvest is not allowed.
- 2907 • Retain, where feasible, resources values that would provide future owl habitat.
- 2908 • Comply, where feasible, with “Overall Resource Management” measures specified in the HCP,
2909 including retention of canopy cover, ground cover, habitat along streams, and a variety of tree
2910 sizes and species within WLPZs.
- 2911 • Implement research on habitat overlap and interactions between Spotted Owls and Barred
2912 Owls.
- 2913 • Conduct surveys according to approved Spotted Owl protocol that accounts for occupancy and
2914 Barred Owl presence, and contact the USFWS for direction as appropriate.
- 2915 • Prepare annual report to record actual instances and number of Spotted Owl sites displaced,
2916 level of habitat loss within owl sites, actual and estimated levels of displacement of past year,
2917 estimated levels of displacement for future year, estimate number of owl sites and amount of
2918 owl habitat, pre- and post-harvest estimates of snags and residual trees in THP areas, results of
2919 nest and set-aside monitoring, and assess efficacy of measures to date.
- 2920 • Provide Department with letter to document financial assurances for HCP implementation.
- 2921

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Following the first spotted owl surveys of Green Diamond's (formerly Simpson Timber Company) in 1989, it was recognized that the high densities of spotted owls on intensively managed timberlands in coastal California represented something potentially unique in spotted owl ecology (Thomas et al. 1990). However, the HCP was developed and approved in 1992 based on a single master's thesis of spotted owl habitat use in coastal managed timberlands (Folliard 1983, Folliard et al. 2000). Due to the uncertainty related to the HCP's conservation strategy and level of take, a major 10-year review was mandated to address the following questions:

- A comparison of actual and estimated levels of owl displacement;
- A comparison of actual and estimated distribution of owl habitat;
- A reevaluation of the biological basis for the conservation strategy based on the data collected through the research program and other sources;
- A detailed analysis of efficacy of and continued need for the set-asides and of the long-term viability of the owl population on Simpson's property; and
- An estimate of annual owl displacement for the remainder of the permit period.

This review was initiated in 2002 in consultation with the US Fish and Wildlife Service, but due to the extensive amount of data that had been collected as part of the monitoring and research for the HCP and statistically rigorous analyses, the final peer-review and acceptance by the Service did not occur until 2010 (Full report in Diller et al. 2010 with summary in Diller et al. 2012). Some of the highlights of the analyses included:

- New spatially explicit definitions of foraging and nesting habitat, and the contribution of habitat quality to owl fitness (i.e., habitat fitness potential following Franklin et al. 2000) with projections of increases in the amount and spatial arrangement of the highest quality habitat (i.e., habitat fitness >1.0) in the future
- Trends in spotted owl survival, fecundity and lambda indicating the owl population was stable under the HCP until 2001 when a downward began as Barred Owl numbers increased.
- The impact of timber harvest resulting in take of owls, as defined under the ESA, on survival and fecundity of owls. This is the only dataset available to directly estimate the impact of timber harvesting on spotted owl demographics and it indicated there was no measurable impact on survival but life-time fecundity was reduced an average of 16.8% for females subjected to take relative to those never taken. Based on an average of three takes per year under the HCP, the impact of take on the owl population within Green Diamond's ownership has been a reduction in fecundity of 2.8%.
- Evidence for an improved spotted owl conservation strategy on managed timberlands that will replace protection of static reserve set-aside areas with a dynamic suite of the highest quality core nesting sites that are consistent with the trends of high habitat quality (fitness) tied to the dynamics of habitat heterogeneity. This conservation strategy along with a suite of habitat retention measures are being proposed in the ongoing development of a new 50-year Forest HCP that will cover Northern Spotted Owls, fishers and tree voles.

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The Service recognized the value of the HCP and the monitoring and research it supported in the Final Critical Habitat Rule by stating: “We have created a close partnership with Green Diamond through development of the HCP, and they have proven to be an invaluable partner in the conservation of the northern spotted owl. Green Diamond has made a significant contribution to our knowledge of the northern spotted owl through their support of continuing research on their lands” (USFWS 2012).

The last annual report (GDRC 2015) described survey results for September 2013 through August 2014 and met the reporting requirements noted above. Since 1992, there has been an overall increase in the total amount of Northern Spotted Owl habitat, indicating that growth of forest stands into owl habitat surpassed forested stands impacted by timber harvest. The primary form of incidental take anticipated in the HCP is the displacement of owls due to modification of owl habitat. It was recognized that such displacement could impair essential behavioral patterns and result in actual death or injury to owls. Rather than examining the circumstances of each case to determine whether a take as defined in the ESA had in fact resulted from Green Diamond’s habitat modification, the implementation agreement calls for reporting as a “displacement” any instance where an owl site itself is harvested or habitat around an owl site is reduced below thresholds established in the HCP. Each displacement is originally reported on the basis of harvest activity in relation to an owl site within a particular home range; however owls that were recorded as displaced can be removed from the cumulative total if minimum occupancy and nesting criteria are met in the years post-harvest. Based on displacement removal criteria, 33 owls that were recorded as displacements (based on harvest activity) have been removed from the cumulative total (i.e., they are not considered displaced under terms of the HCP). Green Diamond’s incidental take permit allows 58 owl pairs to be taken during the 30 year term of the HCP. Although the number of reported displacements per year has been variable, the average is approximately three owl sites per year, leading to 47 owls displaced since 1993 (GDRC 2015).

Regali Estates HCP

This HCP covers 480 acres in Humboldt County, southeast of the town of Ferndale, and is located within the California Coast Province (Regali Estate 1995). Its 20-year term expires August 30, 2015. The plan covered two Northern Spotted Owl activity centers, and contains white-fir, Sitka spruce, redwood, young tree plantations, grassland, and agriculture. The harvest of conifer species resulted in the immediate loss of nesting habitat for one pair. Due to its small size, take afforded by the plan was not deemed to impact regional Spotted Owl populations. Measures set for the plan included: (1) Retention of habitat around nest sites; (2) No harvest impact for a portion of the covered area; (3) Retention of foraging habitat in harvested areas; (4) Salvage of only commercially valuable dead and dying trees; (5) Planting of conifer trees in open grassland habitat; (6) Retention of slash piles for prey habitat; (7) Monitoring of owls; and (8) Completion of biannual reports.

Humboldt Redwood Company HCP

The HRC HCP covers 211,700 acres of coast redwood and Douglas-fir forest in Humboldt County, and is located within the California Coast Province (HRC 2014). Currently the Plan Area contains approximately

Comment [LVD86]: 89. I am not sure any of this is very relevant since it is based on a soon-to-be obsolete HCP with outdated definitions of habitat and take accounting. The most relevant information comes from the 10-year review.

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2999 208 Northern Spotted Owl activity centers. The term is 50 years, which means the plan will expire March
3000 1, 2049. The primary covered activity is timber management (timber harvest and regeneration, site
3001 preparation, planting, vegetation management, thinning, and fire suppression) occurring on
3002 approximately 203,000 acres. The HCP requires ongoing monitoring and reporting to ensure that the
3003 conservation measures being implemented are accomplishing the desired outcomes. Through the
3004 adaptive management process, the monitoring results were used to develop an updated HCP on March
3005 31, 2014.

3006 The overall strategy in the Northern Spotted Owl conservation plan, detailed in the HCP, is to (1)
3007 minimize disturbance to Northern Spotted Owl activity sites, (2) monitor to determine whether these
3008 efforts maintain a high-density and productive population of owls on the ownership, and (3) apply
3009 adaptive management techniques when new information on owl biology/ecology is available and to best
3010 assess the performance of management objectives. Specific habitat retention requirements are
3011 provided to conserve habitat for nesting, roosting, and foraging owls.

3012 Northern Spotted Owl management objective outlined in the plan include:

- 3013
- 3014 1. Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 3015 2. Maintain Northern Spotted Owl pairs on an average of 80 percent (over a five-year period) of
- 3016 the minimum 108 activity centers on the ownership. At least 80 of these sites shall be “Level
- 3017 One” sites, and the balance shall be “Level Two” sites.
- 3018 3. Maintain an average reproductive rate of at least 0.61 fledged young per pair (over a five-year
- 3019 period) for the minimum of 108 activity centers on the ownership.
- 3020 4. During the first five years of the HCP, maintain and document the minimum number of activity
- 3021 centers designated in the HCP.

3022 Northern Spotted Owl conservation measures outlined in the plan include:

- 3023
- 3024 1. Establish a Northern Spotted Owl Scientific Review Panel to review and make recommendations
- 3025 for monitoring techniques, offer expert review of monitoring results, and make
- 3026 recommendations on habitat retention standards for maintenance and recruitment of activity
- 3027 centers.
- 3028 2. Conduct a complete annual censuses (or an approved sampling methodology) to monitor all
- 3029 activity centers on the ownership and to determine numbers of pairs, nesting pairs, and
- 3030 reproductive rates.
- 3031 3. If activities are initiated before February 21 and are maintained continuously past the onset of
- 3032 the breeding season (March 1 through August 31) the THP and a 1,000 foot buffer is to be
- 3033 surveyed, with timing and number of surveys dependent on when activities are to occur within
- 3034 the breeding season. For site preparation activities initiated between March 1 and May 31 site
- 3035 visits will be conducted based on known activity centers within 1,000 feet of activity. Details on

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- 3036 how and when site visits are to occur are site specific. No surveys required if timber operations
3037 occur only outside the breeding season.
- 3038 4. Before June 1 each year, at least 80 activity sites shall be maintained using the habitat retention
3039 guidelines detailed in the HCP, referred to as “Level One” habitat retention. Activity sites
3040 selected for “Level One” retention must have supported owls in the previous year and must also
3041 be active for the year in which the site is selected. If a site is determined to be nesting, no
3042 harvesting shall occur during the breeding season within a 1,000-foot radius of the nest tree.
3043 Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the
3044 activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting
3045 habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable
3046 owl habitat must be provided, if present, and less than 50 percent of this shall be under
3047 operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided,
3048 within 1.3 miles of each activity center.
- 3049 5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of
3050 each year to make up the minimum number of activity centers designated by the HCP. “Level
3051 Two” habitat retention must be active for the year in which the site is selected. If a site is
3052 determined to be nesting, no harvesting shall occur during the breeding season within a 1,000-
3053 foot radius of the nest tree. Following the breeding season, 18 acres around the AC shall be
3054 maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC
3055 must be in place. For sites, which have been determined to be occupied by a non-nesting pair
3056 or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if
3057 present, and a 400 foot radius buffer protecting the activity center must be in place. Harvesting
3058 of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat
3059 retention area.
- 3060 6. Activity center that are not needed to meet management objectives above shall receive “Level
3061 Three” protection measures. These activity centers shall have a 1,000-foot buffer during the
3062 breeding season. Timber harvest associated may occur before March 1 or after August 31.
3063 During the breeding season, for activity centers which have been determined to be occupied by
3064 a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as
3065 suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur
3066 during the breeding season in the area adjoining the 18-acre habitat retention area.
- 3067 7. All nest trees shall be marked and be retained if the activity center is harvested.
- 3068 The HCP outlines an objective to conserve habitat diversity and structural components within the plan
3069 area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types
3070 and seral stages are maintained across the landscape over the permit period, as well as structural
3071 components, to contribute to the maintenance of wildlife species covered under the plan, including the
3072 Northern Spotted Owl.
- 3073 Structural components to be retained include:

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- 3074 1. A certain number and size snags that do not pose a human safety hazard.
- 3075 2. A certain number and size of green replacement trees, if snags are not present, with a priority
3076 for trees other than redwood.
- 3077 3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority
3078 given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or
3079 cavities.
- 3080 4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a
3081 maximum of two per acre.
- 3082 5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given
3083 to logs over 30 inches in diameter.
- 3084 In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that
3085 the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section
3086 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in
3087 fact consistent with CESA and meet the conditions set forth in Fish and Game Code section 2081 for
3088 authorizing incidental take of CESA-listed species (CDFW 2014b).
- 3089 The Department found that the mitigation measures identified in the amended ITP and HCP will
3090 minimize, will fully mitigate the impacts of take and will not compromise the continued existence of
3091 Northern Spotted Owl. Measures in the amended versions include, but are not limited to:
- 3092 • Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and
3093 federal governments to ensure their functions as wildlife reserves in perpetuity.
 - 3094 • Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting
3095 habitat in a series of Marbled Murrelet Conservation Areas (MMCAs).
 - 3096 • Conduct a combination of night and daytime surveys and stand searches to locate both known,
3097 and any new, owl activity centers.
 - 3098 • Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other
3099 conservation elements of the HCP for the retention and recruitment of potential foraging,
3100 roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
 - 3101 • Maintain a minimum of 108 activity centers each year over the life of the HCP.
 - 3102 • Maintain an average reproductive rate of at least 0.61 fledged young per pair, over a five-year
3103 period, for the minimum of 108 activity centers on the ownership.
 - 3104 • Conduct complete annual censuses to monitor all activity centers on the ownership and to
3105 determine numbers of pairs, nesting pairs, and reproductive rates.
 - 3106 • Survey the THP area and a 1,000-foot buffer for new operations, except site preparation,
3107 initiated in the period beginning February 21 and ending on or before August 31.
 - 3108 • Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and
3109 detection probabilities using accumulated survey data.

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- 3110 • Submit annual reports describing the activities undertaken, results of the Operating
3111 Conservation Program, and the proposed Operating Conservation Program activities for the next
3112 year for all lands covered by the HCP.

3113

3114 Annual reports for Northern Spotted Owl have been developed since the HCP's inception. The most
3115 current report (HRC 2015) summarizes the Humboldt Redwood Company's survey effort and whether
3116 management objectives were met. The report states,

3117 "Management objective 1 of the HCP, which requires the maintenance of a minimum of 108
3118 activity sites in the HCP area, was met in 2014 with 136 total occupied activity sites including the
3119 108 core sites. There are currently 215 total activity sites (occupied and unoccupied) on the
3120 property. Management objective 2, which calls for maintenance of Spotted Owl pairs on a five
3121 year running average of 80% at core activity sites, was met in 2014 with a running average of
3122 82%. The pair occupancy rate for 2013 was also 84% (91 of the 108 cores sites were occupied by
3123 a pair of Spotted Owls). Management objective 3 requires the maintenance of a five-year
3124 running average reproductive rate of at least 0.61 fledged young per pair for the core sites (for
3125 those pairs monitored to determine reproductive output). Nesting activity was verified for 33 of
3126 the 91 pairs (of the 108 core sites), and a total of 45 young were fledged, resulting in a
3127 reproductive rate of 0.49 in 2014. The five-year running average of the reproductive rate for the
3128 fifteenth year of the HCP is 0.42, below the requirements of management objective 3."

3129 *Mendocino Redwood Company HCP/NCCP (in planning process; not issued)*

3130 The Mendocino Redwood Company (MRC) is in the process of developing a HCP and NCCP with the
3131 federal and state agencies. Once the permit is issued, the term will be 80 years. The HCP/NCCP will
3132 determine how MRC manages threatened and endangered species, rare plants, and natural
3133 communities on their land ownership in Mendocino and Sonoma counties. The Northern Spotted Owl
3134 will be a covered species in the plan. Approximately 228,800 acres of coast redwood and Douglas-fir
3135 forests exist on MRC land ownership and is located within the California Coast Province. Up to date
3136 progress on the HCP/NCCP development can be found on the MRC website (<http://www.mrc.com>).

3137 *Terra Springs LLC HCP*

3138

3139 The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the
3140 Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa
3141 County west of the city of St. Helena, and is located within the California Coast Province. The plan has a
3142 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year
3143 old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered
3144 lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the
3145 covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded
3146 by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to
3147 maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while
3148 accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting,

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3149 roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their
3150 management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees,
3151 felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices,
3152 retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous
3153 snags, retention of down logs; (3) Timber operations to cease within a 1000 ft buffer of the owl activity
3154 center during the breeding season; (4) Monitor the Spotted Owl site for five years subsequent to the
3155 timberland conversion; and (5) Annual reporting for the first 5 years of the permit.

3156 *Fruit Growers Supply Company HCP*

3157
3158 The Fruit Growers Supply Company (FGS) HCP covers commercial timberland owned and managed by
3159 FGS in Siskiyou County, totaling 152,178 acres (FGS 2012). The Plan Area is within the California Klamath
3160 Province and California Cascades Province. The HCP has a 50 year term that expires November 27, 2062.
3161 In February 2014, FGS notified the Department that the federal BO was issued and requested that the
3162 Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1.
3163 In March 2014, after an amendment to the HCP to fully meet mitigation standards, the Department
3164 found that BO and its related ITS and ITP, and the HCP were consistent with CESA and meet the
3165 conditions set forth in Fish and Game Code section 2081 for authorizing incidental take of CESA-listed
3166 species (CDFW 2014c).

3167 In April 2015, the United States District Court, Northern District of California, found FGS's HCP to be
3168 invalid for the incidental take of two threatened species, the Northern Spotted Owl and the Southern
3169 Oregon/Northern California Coast Coho Salmon. The Order on Cross-Motions for Summary Judgment in
3170 the case *Klamath-Siskiyou Wildlands Center, Center for Biological Diversity, and Klamath Forest Alliance*
3171 *vs. National Oceanic and Atmospheric Administration, National Marine Fisheries, and the United States*
3172 *Fish and Wildlife Service, and Fruit Growers Supply Company* states, "For the reasons explained below,
3173 the Court ... finds the incidental take permits issued by the Services, the biological opinion issued by
3174 NMFS, and the Final Environmental Impact Statement invalid." The HCP amendment to fully meet
3175 mitigation standards was not considered in this case.

3176 Timber management was the primary activity affecting approximately 150,000 acres. FGS land consists
3177 of three management units: Klamath River covering 65,340 acres, Scott Valley covering 39,153 acres,
3178 and Grass Lake covering 47,685 acres. Klamath River and Scott Valley units are dominated by second-
3179 growth mixed evergreen forests that include Douglas-fir, incense-cedar, white fir, ponderosa pine, sugar
3180 pine, canyon live oak, Pacific madrone, California black oak, and Oregon white oak. The Grass Lake unit
3181 contains three major forest types: Sierran Montane Forest and Upper Montane Forest at higher
3182 elevations and Northern Yellow Pine Forest at lower elevations. The Northern Yellow Pine is most
3183 common in the Grass Lake unit, and is dominated by ponderosa pine and white fir. The hardwood
3184 understory species (e.g., oak species and madrone) are largely absent in this unit. Because most of FGS
3185 land has been in commercial timber production since the early 1900s, forests are relatively young (less
3186 than 80 years old) with only small, isolated patches of older stands. Less than 1 percent of the forested
3187 area in the three management units are in WHR size class 5 (> 24 inches dbh) and are considered late-

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3188 seral stage. Most of the forested lands (79-93%) are in WHR size classes 3 and 4 (6-24 inches dbh) and
3189 are considered mid-seral.

3190 Covered Activities had the potential to alter forest characteristics, and influence the availability and
3191 quality of habitat for Northern Spotted Owls. Northern Spotted Owl surveys on FGS lands and adjoining
3192 federal and private lands have shown that many activity centers are located on or have a home range
3193 that extends onto the FGS ownership.

3194 Safe Harbor Agreements

3195
3196 The USFWS states (<http://www.fws.gov/endangered/landowners/safe-harbor-agreements.html>):

3197 “A Safe Harbor Agreement (SHA) is a voluntary agreement involving private or other non-
3198 Federal property owners whose actions contribute to the recovery of species listed as
3199 threatened or endangered under the ESA [see section 10(a)(1)(A)]... In exchange for actions that
3200 contribute to the recovery of listed species on non- Federal lands, participating property owners
3201 receive formal assurances from the Service that if they fulfill the conditions of the SHA, the
3202 Service will not require any additional or different management activities by the participants
3203 without their consent. In addition, at the end of the agreement period, participants may return
3204 the enrolled property to the baseline conditions that existed at the beginning of the SHA.”

3205 There are two SHAs covering Northern Spotted Owl in California, Forster-Gill, Inc., and The Fred M. van
3206 Eck Forest Foundation.

3207
3208 *Forster-Gill, Inc., Safe Harbor Agreement*

3209
3210 The Forster-Gill SHA was issued in June 2002 has a 90-year term, and consists of 236 acres in Humboldt
3211 County one mile north of the town of Blue Lake (USFWS 2002). The majority of the property (91%)
3212 contains young growth coastal redwood (30-35 years old), with 216 acres containing WHR type 4D (12-
3213 24 inch dbh and 60-100 percent canopy closure). At the time of the SHA issuance two owl activity
3214 centers were adjacent to the property, both associated with one pair.

3215 In the SHA, Forster-Gill agrees to enhance and maintain approximately 216 acres of forested Northern
3216 Spotted Owl habitat through timber harvest management designed to create uneven-aged stands with
3217 large tree components, characteristic of high quality owl habitat. Specifically, the SHA will:

- 3218 • Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
3219 • Retain all snags not posing a hazard risk.
3220 • Conduct annual owl surveys on property and within a 500 foot radius around the property.
3221 • Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
3222 • Ensure no harvest occurs within 1,000 ft of any active owls nest site.

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- 3223 • Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single
- 3224 tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and
- 3225 approved by USFWS.
- 3226 • Conduct timber stand inventories and provide USFWS with data.
- 3227 • Allow USFWS or other agreed-upon party access to property for monitoring and management
- 3228 activities.

3229
3230 *The Fred M. van Eck Forest Foundation Safe Harbor Agreement*
3231

3232 The van Eck Foundation SHA was issued in August 2008 has a 90-year term, and covers management
3233 activities on 2,163 acres of land in Humboldt County owned by The Fred M. van Eck Forest Foundation
3234 (USFWS 2008a). Four management units are identified, of which three (Lindsay Creek, Squaw Creek and
3235 Fieldbrook) are located in the Lindsay Creek watershed about one mile of the town of Fieldbrook. The
3236 fourth unit, Moonstone, is located in the about ½ mile east of the community of Westhaven. The main
3237 forest types found include redwood, Douglas-fir, grand fir, western hemlock, and Sitka spruce.
3238 Approximately 80% of the land contains nesting and roosting habitat, with dense canopy cover, and
3239 trees over 16 inch dbh. At the time of SHA issuance, no Spotted Owl nesting was documented, however
3240 roosting single and pairs were.

3241 The SHA incorporates the terms of the conservation easement granted to Pacific Forest Trust (PFT) in
3242 2001. The conservation easement includes performance goals and restrictions that create forest
3243 component recognized as high quality owl habitat.

3244 In the SHA, van Eck Foundation agrees to maintain and protect 6.5 acres of nesting and roosting habitat
3245 surrounding an AC, and limit harvesting to single-tree selection or group selection with a target of
3246 retaining native species and trees that grow vigorously. Exceptions will be made for trees that have been
3247 identified for snag or wildlife tree retention. Canopy cover will remain above 80% (averaged across the
3248 stand) upon completion of harvesting activities. Specifically, the SHA will:

- 3249 • Comply with the conservation strategy, including management performance goals, restrictions
- 3250 on harvest, and road construction and maintenance conditions.
- 3251 • Retention of all snags not posing a safety hazard.
- 3252 • Conduct protocol-level surveys and determine reproductive status on property and within 500
- 3253 foot radius off property, with annual surveys at Lindsay Creek, Squaw Creek, and Fieldbrook
- 3254 units, and one year prior to harvesting activities at Moonstone unit.
- 3255 • Implement protection measures for up to five activity centers.
- 3256 • Conduct following protection measures: maintain a 300 foot no-harvest-buffer on up to two
- 3257 activity centers, maintain a 100 foot limited-harvest-buffer on up to three activity centers, no
- 3258 harvest operations to occur within 1,000 feet of any activity center during the breeding season,
- 3259 and no harvest of any known owl nest trees.
- 3260 • Cooperate with USFWS on Barred Owl control measures.
- 3261 • Submit timber inventory reports according to management units
- 3262 • Allow the USFWS or other agreed-upon party, access to property.

Comment [LVD87]: 90.Same comment as earlier

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- 3263 • Conduct annual protocol-level surveys and determine reproductive status and success at owl
3264 nest sites found for a minimum of three years post-harvest.

3265
3266 Exemption Harvest
3267

3268 Exemption harvest is meant to assist private landowners wanting/needing to remove trees and may
3269 allow the removal to be exempt from the THP process. The different types of exemptions available
3270 include:

- 3271 • Forest Fire Prevention Exemption
3272 • Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption
3273 • Less Than Three Acre Conversion Exemption
3274 • Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption
3275 • Public Agency, Public and Private Utility Right of Way Exemption
3276 • Woody Debris and Slash Removal Exemption
3277 • Removal of Fire Hazard Tree within 150 feet of a Structure Exemption
3278 • Drought Mortality Amendment Exemption 2015
3279 • Protection of Habitable Structures Exemption 2015
3280

3281 Any of the above mentioned exemptions may impact Northern Spotted Owls either directly through
3282 habitat removal or indirectly through noise or visual disturbance, depending on the location and on the
3283 yearly timing of operations

3284 Exemption harvest operations must comply with all aspects of the Forest Practice Rules and various
3285 restrictions regarding the operations under the various emergency conditions. In exemption harvest
3286 actions, no known sites of rare, threatened or endangered plants or animals are to be disturbed,
3287 threatened or damaged. However, Northern Spotted Owl protocol-level surveys and habitat
3288 assessments are not generally required by the Forest Practice Rules to operate under an exemption.

3289 Not all exemptions require an RPF certification. Those that do not require the certification are:
3290 Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption, the Public Agency,
3291 Public and Private Utility Right of Way Exemption, Drought Mortality Amendment Exemption and the
3292 Removal of Fire Hazard Trees within 150 feet of a Structure Exemption.

3293 The Christmas Tree/Dead, Dying or Diseased Fuel wood or Split Products Exemption has been available
3294 during the entire time period in which the Northern Spotted Owl has been listed as threatened by the
3295 USFWS. Tree removal is limited to less than 10 percent of the average volume per acre and can be
3296 applied to an entire ownership on any size.

3297 The Forest Fire Prevention Exemption allows the harvest of green merchantable trees, but the logging
3298 area is limited to 300 acres in size and a statement of the postharvest stand stocking level is required as
3299 required in 1038(i) in the Forest Practice Rules.

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3300 The Less Than Three Acre Conversion Exemption is applicable to a conversion of timberland to a non-
3301 timber use only, of less than 3 acres in one contiguous ownership, whether or not it is a portion of a
3302 larger land parcel and shall be not part of a THP. Within one month of the completion of timber
3303 operations, including slash disposal, the timberland owner shall submit a work completion report to CAL
3304 FIRE.

3305 The Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption is not limited to 10% of
3306 the volume per acre and the landowner must notify CAL FIRE of the completion of timber operations
3307 within 30 days of their cessation.

3308 The Public Agency, Public and Private Utility Right of Way Exemption , working with Public Resources
3309 Code section 4628 and Forest Practice Rules section 1104.1(b) exempts public agencies from the
3310 requirement to file an application for timberland conversion or a THP when they construct or maintain
3311 rights of way on their own property or that of another public agency. This exemption extends to
3312 easements over lands owned in fee by private parties. This exemption is not available for rights of way
3313 granted from one private landowner to another.

3314 The Woody Debris and Slash Removal Exemption allows the removal of woody debris and slash that is:
3315 (1) located outside the WLPZ, (2) within the reach of loading equipment operating on existing roads and
3316 landings, (3) developed during timber operations, (4) delivered as combustion fuel for the production on
3317 energy, and (5) in compliance with the conditions of Forest Practice Rules section 1038 subdivision (b)
3318 paragraphs (3),(4),(6),(7),(8) and (10).

3319 The Removal of Fire Hazard Trees within 150 feet of a Structure Exemption allows only trees within 150
3320 feet of an approved and legally permitted structure that complies with the California Building Code
3321 (includes only structures designed for human occupancy, garages, barns, stables and structures used to
3322 enclose fuel tanks) may be harvested under this Notice of Exemption.

3323 The Drought Mortality Exemption was adopted in 2015 by the Board of Forestry due to the prolonged
3324 drought and supercedes the provisions of any other exemption in the same harvest footprint (harvesting
3325 of dead and dying trees). Trees that are dead or trees with fifty percent or more of foliage-bearing
3326 crown that is dead or fading in color are eligible for removal. Under this exemption, it is required to
3327 retain an average for the harvest area of not less than one decadent and deformed tree of value to
3328 wildlife, snag or dying tree per acre that is greater than sixteen inches diameter breast height and
3329 twenty feet tall. This provision does not apply within 100 feet of habitable structures, roads, fire
3330 suppression ridges and infrastructure facilities such as transmission lines and towers or water
3331 conveyance and storage facilities. This exemption requires an RPF signature when timber operations on
3332 a cumulative harvest area exceed twenty acres per total ownership.

3333 The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to
3334 the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet
3335 from any point of an habitable structure that complies with California Building Code for the purpose of
3336 reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily
3337 comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the

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3338 treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2,
3339 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project
3340 area shall be increased in the post-harvest stand.

3341 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3342 approximately 41,767,250 acres (1992 to 2013) have been included in a tally of lands exempted for
3343 harvest in counties within the range of Northern Spotted Owl (CAL FIRE 2014). These acres do not
3344 represent operational acres (actual acres harvested) but only notification acres (possible intended acres
3345 harvested). Operational acre reporting is not required; therefore there is no data representing the
3346 precise amounts or locations of areas harvested under an exemption. Some of these acres are most
3347 likely outside the known range of the Northern Spotted Owl. In addition, some landowners prepare
3348 notifications for their entire ownership yearly; yet may only operate on any or only a small area, thereby
3349 obviously ~~possibly~~ compounding this acreage total since the approximately 41.8 million represents over
3350 five times the total acreage of forested lands in private ownership within the range of the Northern
3351 Spotted Owl in California.

Comment [LVD88]: 91. This is a very misleading number. Above it said there was 14.3 million acres of forested land within the range of the NSO in CA of which 7.8 million is in private ownership. So to have over 5x as much land exempted from timber harvest means the majority of the total comes from redundant inclusions of exempted lands. It doesn't make sense to report a total unless you can get some idea how many total acres
92.

3352 Volume of timber removed under an exemption is reported to the Board of Equalization (BOE), and is
3353 another way to assess levels of exemption harvest. With the precise location and yearly timing of the
3354 volume reported unknown, specific impact assessments cannot be developed. However, the total
3355 volume harvested, average volume amounts by each county and total percentage of harvest volume
3356 may be enough to determine that more information is needed. Yearly exemption harvest volume from
3357 the counties within the known Northern Spotted Owl range date back to 1990 and average
3358 approximately 49,456 MBF (1 MBF = 1,000 board-feet) and represent approximately 4.87% of total
3359 volume harvested. The highest total amount harvested occurred in 1994 totaling 164,232 MBF,
3360 accounting for 15% of the total volume harvested that year. The total exemption volume harvested
3361 during the time that Northern Spotted Owl has been listed as threatened by the USFWS is 1,186,954
3362 MBF. The largest amount of exemption volume recorded is from Shasta in 1994 totaling 79,993 MBF,
3363 with the largest percentage of total volume coming from Napa (1994), Marin (1996), Glenn (2003), and
3364 Lake (2005), where 100% of the total volume harvested was exemption volume (BOE 2014). These
3365 volume amounts do not include all volume as the BOE reporting requirements only require volume
3366 reporting when \$3000.00 is obtained. The BOE does not track the volume that is less than \$3000.00 in
3367 value (A. Tenneson, personal communication, November 18, 2015).

3368 It is not known if the long-term exemption harvesting on private lands in California is limiting affecting
3369 Northern Spotted Owl populations, but exemption harvesting may reduce well defined/ critical habitat
3370 elements over time. The current exemption harvest process does not require owl habitat analysis or
3371 surveys and may directly impact Northern Spotted Owl, and therefore more information is needed to
3372 fully assess the impacts from exemption harvest.

Comment [LVD89]: 93. Same comment as above.

3373 Emergency Harvest

3374
3375 Private landowners may cut or remove timber under an emergency basis if “emergency conditions” exist
3376 pursuant to Forest Practice Rules section 895.1. Emergency conditions are defined as, “... those

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3377 conditions that will cause waste or loss of timber resources to the timber owner that may be minimized
3378 by immediate harvesting of infected, infested or damaged timber or salvaging down timber; or those
3379 conditions that will cause appreciable financial loss to the timber owner that may be minimized by
3380 immediate harvesting of timber.”

3381 Types of emergency conditions include:

- 3382 • Dead or dying trees as a result of insects, disease, parasites, or animal damage.
- 3383 • Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood,
3384 landslide, or earthquake.
- 3385 • Dead or dying trees as a result of air or water pollution.
- 3386 • Cutting or removing trees required for emergency construction or repair of roads.
- 3387 • Cutting and removal of hazardous fuels.
- 3388 • Treatments to eradicate an infestation of Sudden Oak Death.

3389
3390 There is some overlap with types of emergency conditions between Exemption and Emergency harvests.
3391 Exemption Harvest allows only 10% of volume of “dead and dying trees” to be removed, while under an
3392 Emergency Harvest the minimum stocking standards need to be met and does not allow the harvest of
3393 merchantable sawlogs. In addition, Emergency Harvests allow removal of dead trees or trees instituting
3394 an obvious large scale economic loss, whereas Exemption Harvest does not.

3395 Emergency Harvest operations must comply with all aspects of the Forest Practice Rules specific to
3396 emergency operations (Forest Practice Rules § 1052 subd. (a)). Before cutting or removing timber on an
3397 emergency basis, an RPF on behalf of a timber owner or operator must submit a Notice of Emergency
3398 Timber Operations. In Emergency Harvest, no known sites of rare, threatened or endangered plants or
3399 animals are to be disturbed, threatened or damaged. However, Northern Spotted Owl protocol-level
3400 surveys and habitat assessments are not generally required to operate during emergency conditions.

3401 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3402 between 1992 and 2013 approximately 344,542 acres (CAL FIRE 2014) have been notified for emergency
3403 harvest in counties within the owl’s range. These acres may not represent operational acres (actual
3404 acres harvested) but only notification acres (intended acres harvested). Depending on the emergency
3405 condition and stocking requirement, operational acre reporting may not be required; therefore there is
3406 no acreage data or mapping data representing the precise amounts or locations for all emergency
3407 operational areas.

3408 Emergency harvest operations mostly occur in areas where forest stand conditions are dead or fallen,
3409 forest habitat conditions not meeting the definitions of suitable habitat for Northern Spotted Owl under
3410 the Forest Practice Rules, however indirect impacts may occur as a result of the emergency operation.
3411 The emergency notification data is compiled yearly by county, therefore Northern Spotted Owl range-
3412 specific data is not available. Of the total notification acres between 1992 and 2013, some are most
3413 likely outside the known range of the Northern Spotted Owl as the known range line does not include all
3414 of the county area within this acreage data set.

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3415 | It is not known if the long-term emergency harvesting on private lands in California is ~~limiting-affecting~~
3416 Northern Spotted Owl populations, however, there is some evidence that salvage logging effects use of
3417 burned areas by Spotted Owls. See the discussion of wildfire in the Threats section for additional
3418 discussion on this type of emergency harvest. Some indirect impacts, such as noise disturbance, may be
3419 occurring as a result of emergency operations but level and extent of this potential impact is not well
3420 documented. More information is needed to fully assess the impacts to Northern Spotted Owl from
3421 emergency harvesting.

3422 Other Management Actions

3423 3424 *Forest Certification Programs*

3425
3426 Some private landowners in California have voluntarily worked with organizations to achieve
3427 certification for their forest landholdings and forestry practices. There are numerous organizations that
3428 certify forest products, with Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI)
3429 being two of the largest. In order for a landowner to attain certification, they must achieve certain
3430 conservation requirements and initiate specific management activities to meet these requirements. For
3431 example, a landowner may be required to increase retention in even-aged units, and to achieve this 10-
3432 30% of the pre-harvest basal area might be retained in a clumped or dispersed fashion. Another
3433 example that could benefit Northern Spotted Owl would be protection of old-growth and legacy trees
3434 through the creation of policy and planning documents that ensure their identification and protection
3435 (T. Bolton, personal communication, September 5, 2014).

3436 The FSC conducts audits to ensure compliance with FSC certification. In addition, the FSC certification
3437 has geographic-specific indicators for the US and Pacific Coast region (FSC 2010a, S. Chinnici, personal
3438 communication, September 3, 2014) and has developed a draft framework for assessing “High
3439 Conservation Value Forests” (HCVFs) to help land managers identify lands with high conservation value
3440 (FSC 2010b). Lands determined to be of high conservation value have extra requirements for
3441 monitoring. Conserving these lands enables landowners to get credit for conservation while being able
3442 to manage other parts of their land for timber products (FSC 2010a).

3443 The Department does not have an accounting of the number of acres of timberland covered by a forest
3444 certification program, nor the quality of the management activities required to meet certification.
3445 Therefore, there is not enough information available to suggest what kind of impact, if any, forest
3446 certification has had on Northern Spotted Owl populations. However, certification programs may have a
3447 positive effect on Northern Spotted Owl in cases where more foraging, nesting, or roosting habitat is
3448 maintained than that called for in the Forest Practice Rules.

3449 *Conservation Easements*

3450
3451 Most of the conservation easements in forested environments within the Northern Spotted Owl range
3452 allow for some sort of timber harvest. The Department is involved in only a portion of easement/title
3453 projects, and of these projects, the Department is typically not a landowner, title-holder, or manager of
3454 these lands. While working with landowners and managers on the easement/title conditions, the

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3455 Department Lands Program staff suggests conditions conducive to the protection and conservation of
3456 wildlife and their habitats.

3457 Due to the variability of landowner needs, the conditions agreed upon for easements constitute a wide
3458 range of habitat protection. Thus, it is difficult to draw conclusions as to how easements/titles are
3459 contributing to Northern Spotted Owl conservation. Additionally, these areas are not rigorously studied
3460 specific to the Northern Spotted Owl.

3461 *State Forests*

3462
3463 CAL FIRE operates eight Demonstration State Forests in California, totaling about 71,000 acres. A
3464 majority of these forests are actively managed as timberlands and annually produce on average about
3465 30 million board feet of wood. About 53,145 actively-managed acres of State Forest lands occur within
3466 the range of the Northern Spotted Owl; this includes Ellen Pickett State Forest (158 acres), Las Posadas
3467 State Forest (843 acres), Boggs Mountain Demonstration State Forest (3,425 acres), and Jackson
3468 Demonstration State Forest (48,719 acres). State Forests are intended to be used for experimentation
3469 and demonstration of various silvicultural methods for their economic and environmental/scientific
3470 value. The State Forests have management plans that are periodically reviewed by BOF and all timber
3471 harvesting activities on State Forests must comply with the Forest Practice Act and the Forest Practice
3472 Rules, including the measures to avoid take of Northern Spotted Owl found in Forest Practice Rules
3473 sections 919.9 and 919.10.

3474 Jackson Demonstration State Forest (JDSF) is the largest of the eight forests (49,000 acres) and
3475 represents nearly 70% of the total State Forest acreage in California. This forest has been managed and
3476 harvested since 1862 and was acquired by the State in 1947. Located in central Mendocino County, the
3477 forest consists primarily of coast redwood and Douglas-fir, with some old-growth coast redwood
3478 remaining. Forest stands on JDSF have been managed on an even-aged and uneven-aged basis under
3479 various silvicultural systems; however, special restrictions are put on even-aged management and clear-
3480 cutting (CDF 2008, CDF 2014).

3481 The JDSF Management Plan (CDF 2008) contains a Northern Spotted Owl Conservation Strategy, with
3482 the goal to “maintain or increase the number and productivity of nesting owl pairs through forest
3483 management practices that enhance nesting and roosting opportunities and availability of a suitable
3484 prey base.” CAL FIRE monitors certain Northern Spotted Owl activity centers on JDSF and the
3485 Management Plan conditions are nearly identical to the Forest Practice Rules.

3486 *State Parks*

3487
3488 The California Department of Parks and Recreation (CA State Parks) manages 280 park units in
3489 California; 64 of these park units are within the range of the Northern Spotted Owl, totaling 214,286
3490 acres. CA State Parks’ mission, in addition to preserving biodiversity, includes protecting cultural
3491 resources and creating recreation opportunities. CA State Parks does not have a management plan for
3492 the Northern Spotted Owl and management for species occurs at the park unit scale. Each park unit

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3493 prepares a general plan that describes the range of activities occurring within the park unit and resource
3494 protection that the park unit enables.

3495 The largest State Park (SP) in the Northern Spotted Owl range, Redwood National and State Parks, is
3496 jointly managed by the NPS and CA State Parks and includes: Redwood National Park, Jedediah Smith
3497 Redwoods SP, Del Norte Coast Redwoods SP, and Prairie Creek Redwoods SP. RNSP does not have
3498 specific Northern Spotted Owl management actions in its General Management Plan/General Plan, but
3499 does have vegetation management actions for old-growth, second-growth, prairie and fires. Old-growth
3500 forests are protected, managed, and restored to provide habitat for species and to reduce fire hazards.
3501 Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to
3502 reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak
3503 woodlands and prairies is managed through tree removal and burning. Nine management zones within
3504 the RNSP delineate the degree of human influence and development on that can occur on the landscape
3505 (NPS 2000a).

3506 Similar to Redwood National and State Parks, the second largest park unit within the Northern Spotted
3507 Owl range, Humboldt Redwoods State Park, does not engage in specific management activities for
3508 Northern Spotted Owl, but protects and manages for old-growth stands to be sustained over time (CDPR
3509 2001).

3510 California State Parks do not engage in regular surveys for Northern Spotted Owl within State Parks,
3511 though surveys sometimes occur before park projects are started. However, adjacent timberland
3512 owners routinely survey Northern Spotted Owl activity centers within State Parks (T. Fuller, personal
3513 communications, September 2, 2014).

3514 *University of California Natural Reserves*

3515
3516 Comprised of more than 756,000 acres across 39 sites and representing most major California
3517 ecosystems, the UC Natural Reserve System (UCNRS) is the largest university-administered reserve
3518 system in the world. By supporting university-level teaching, research, and public service, the UCNRS
3519 contributes to the understanding of and wise stewardship of California's natural resources. Five UCNRS
3520 sites (totaling 4,625 acres) across California occur within the range of the Northern Spotted Owl, though
3521 there are no management plans or Northern Spotted Owl SO data for individual reserves (UC 2014).
3522 Angelo Coast Range Reserve has had three Northern Spotted Owl territories through since the late-
3523 1980s, but since Barred Owls were detected in the area starting in 1999 Spotted Owls have not been
3524 detected at any of the three sites (A. Franklin, personal communication, March 23, 2015).

3525 *Department Ecological Reserves*

3526
3527 Authorized by the California Legislature in 1968 and administered by the Department, the ecological
3528 reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats,
3529 and to provide areas for education and scientific research. The system now encompasses 119 properties
3530 totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur
3531 within the range of the Northern Spotted Owl; however there are no management plans for the system

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3532 or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception
3533 is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by
3534 BLM, which manages for late seral habitat benefiting Spotted Owls.

3535 *Fisheries Restoration Grant Program*

3536 As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern
3537 Spotted Owls and their habitat are required for each project funded. The purpose of FRGP is to support
3538 restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must
3539 provide a detailed proposal that thoroughly addresses all criteria of the FRGP, one of which is avoidance
3540 and minimization measures for Northern Spotted Owls if a project proposes to conduct work in owl
3541 habitat. The geographic area covered by FRGP almost completely overlaps with the Northern Spotted
3542 Owl range in California, therefore the potential for a project be in owl habitat is high. Once a project is
3543 approved, the proponent must obtain a Lake or Streambed Alteration Agreement (LSAA) from the
3544 Department to comply with the CEQA. The LSAA will include conditions for the protection of wildlife and
3545 habitat, and must be followed during project activities.

3546 To avoid potential impacts to Northern Spotted Owls FRGP projects must adhere to the following, as
3547 noted in the LSAA:

- 3548 • Work with heavy equipment at any site within 0.25 miles of suitable habitat for the Northern
3549 Spotted Owl shall not occur from November 1 to July 9.
- 3550 • The work window at individual work sites may be advanced prior to July 31, if protocol surveys
3551 determine that suitable habitat is unoccupied.
- 3552 • If these mitigation measures cannot be implemented or the project actions proposed at a
3553 specific work site cannot be modified to prevent or avoid potential impacts to Northern Spotted
3554 Owls or their habitat, then activity at that work site will be discontinued and the project
3555 proponent must obtain incidental take authorization from the USFWS.
- 3556 • For projects contained within streams and watersheds included in a USFWS Habitat
3557 Conservation Plan the mitigation measures contained within those Habitat Conservation Plans
3558 shall be followed.

3559 The grant program is very successful and funds numerous projects each year. In fiscal year 2013/2014
3560 alone, FRGP funded approximately \$16.5 million dollars in 56 projects, of which 44 projects were located
3561 within the range of the Northern Spotted Owl.

Threats (Factors Affecting Ability to Survive and Reproduce)

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3564 Historical Habitat Loss and Degradation

3565 Historical Habitat Loss and Regrowth

3566 Historical (pre-logging) variability in forest age and structure in the range of the Northern Spotted Owl
3567 was controlled by a function of natural processes, including wildfires (Courtney et al. 2004). Estimates of
3568 pre-logging extent of old forest in western Washington and Oregon are relatively consistent and range
3569 from 60 to 72% of the landscape (Courtney et al. 2004). However, Wimberly et al. (2000) estimated
3570 that old growth forests covered between 25 and 75% of the Oregon Coast Range province over a 3,000
3571 year simulation. At the scale of late successional reserves (40,000 ha) old growth, they estimated
3572 percentages varied from 0 to 100%. When the USFWS listed the Northern Spotted Owl as threatened in
3573 1990, estimates of historical Spotted Owl habitat loss ranged from 60 to 88% loss rangewide since the
3574 early 1800s (USFWS 2011a). Much of this loss was attributed to timber harvest and to land-conversion,
3575 and was concentrated mostly at lower elevations and in the Coast Ranges (USFWS 2011a). This pattern
3576 of historical loss is apparent in the current distribution of suitable habitat, with large areas of coastal
3577 and low lying areas that no longer support suitable nesting and roosting habitat (see Figure 4).

3578 Prior to 1990, the annual rate of removal of Spotted Owl habitat on national forests as a result of logging
3579 had been about 1% per year in California and 1.5% per year in Oregon and Washington (USFWS 1990,
3580 2011). At the time, it was projected that future rates of habitat removal would eliminate all nesting and
3581 roosting habitat on non-protected BLM lands in Oregon, with the exception of the Medford District, by
3582 the year 2016 (USFWS 1990). Estimates from the decades before 1990 indicate that harvest rates on
3583 private industrial lands were consistently about twice the average rate of harvest on public land (Cohen
3584 et al. 2002). Regarding harvest rates on private industrial and non-industrial lands, Bigley and Franklin
3585 (2004) estimated harvest rates in the late 1980s and early 1990s for private industrial land of 2.4% per
3586 year, and harvest rates on non-industrial lands increased from 0.2% in the 1970s to a rate similar to that
3587 of the private industrial lands by the early 1990s.

3588 Historical logging of the old growth in coastal California began in the late 1800's and approximately 95%
3589 of coastal old growth forests had been logged by the 1970's. Regrowth of second growth habitat
3590 followed the early extensive elimination of Spotted Owl habitat in the California Coastal Province.
3591 Although there were no surveys conducted to determine when the second growth became suitable
3592 habitat for Spotted Owls, when the first extensive surveys of managed timberlands began in the early
3593 1990's, a high proportion of the second growth forests were supporting substantial numbers of Spotted
3594 Owls (Diller and Thome 1999, plus all the other timber company surveys).

3595 *Assessing Habitat Loss through Implementation of the Northwest Forest Plan*

3596 The Northern Spotted Owl was listed under the federal Endangered Species Act in 1990 in part because
3597 of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised
3598 recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls,
3599 ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or degradation from stand

Comment [LVD90]: 94.I think it is quite misleading that there is no mention of regrowth of habitat following historical logging of the old growth.

Comment [LVD91]: 95.Wimberly, J. C., T. A. Spies, C. J. Long and C. Whitlock. 2000. Simulating historical variability in the amount of old forests in the Oregon Coast Range. Conservation Biology 14:167-180.

Comment [LVD92]: 96.I am not sure I have all the details correct here, but somewhere there needs to be recognition of habitat regrowth. Timber harvest or any other form of stand-replacing disturbance is not a permanent loss of habitat. Obviously regrowth occurs at different rates in different portions of the state, but every owl not living in an old growth forest is evidence that regrowth does occur.

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3600 replacing wildfire and other disturbances, and loss of amount and distribution of Spotted Owl habitat as
3601 a result of past activities and disturbances (USFWS 2011^a). To address ongoing decline of Northern
3602 Spotted Owl habitat across the range, the NWFP established reserved lands including late-seral reserves,
3603 adaptive management reserves, congressionally reserved lands, managed late-successional areas, and
3604 larger blocks of administratively withdrawn lands (USDA and USDI 1994) (Figure 11). These are described
3605 in more detail above. It was assumed that habitat in reserves would improve over time as successional
3606 processes led to more mature forests, however, this is a slow process and so recruitment of habitat
3607 conditions on reserves was expected to take many decades. It was also assumed that habitat outside of
3608 reserves would continue to decline due to timber harvest and other disturbances but that dispersal
3609 habitat would be maintained in order to facilitate movement between reserve lands. Given the
3610 continued Northern Spotted Owl population declines and the increasing threat of the Barred Owl, the
3611 revised recovery plan recommended conserving occupied sites and unoccupied, high-value Spotted Owl
3612 habitat on state and private lands wherever possible (USFWS 2011^a).

3613 In order to understand the degree to which the NWFP contributes to conservation of owl habitat, the
3614 rangewide trends in habitat are regularly assessed. To date, assessments have been performed at the
3615 10-year and 15-year time points (Davis and Lint 2005, Davis et al. 2011). The recent assessment
3616 estimated rangewide habitat changes on federal and nonfederal lands from 1994 through 2007 for
3617 California and from 1996 through 2006 in Oregon and Washington by comparing vegetation maps for
3618 two bookend time periods. In addition to rangewide changes, trends for each physiographic province
3619 and for each state are also reported (Davis et al. 2011). The assessment tracks changes in Northern
3620 Spotted Owl nesting and roosting habitat, and also tracks changes in dispersal habitat within and
3621 between the reserves. Foraging habitat is not assessed through modeling for the NWFP. Nesting and
3622 roosting habitat maps were produced through habitat suitability modeling using several forest structure
3623 variables (e.g., percent conifer cover, average conifer dbh, average stand height) and a forest age
3624 variable (Davis et al. 2011). Vegetation stands were placed in one of four categories (highly suitable,
3625 suitable, marginal, and unsuitable), with highly suitable and suitable categories assumed to represent
3626 nesting and roosting habitat (Davis et al. 2011). To assess change, an area was considered to have lost
3627 nesting and roosting habitat if its condition moved from suitable or highly suitable to marginal or
3628 unsuitable.

3629 Although federal lands contain less than half of the total forest land within the entire range of the
3630 Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and
3631 roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and
3632 roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands
3633 lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal
3634 lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance
3635 (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost
3636 on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the
3637 fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl
3638 range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands
3639 has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only

Comment [LVD93]: 97. It is not clear to me the timeframe for these estimated losses. Is it annual rates or based on 1994 through 2007 for California and from 1996 through 2006 in Oregon and Washington? Presumably it is the latter, which makes the rates difficult to compare since they are not the same.

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3640 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on
3641 nonreserved lands.

3642 Conversely, on nonfederal lands most of the nesting and roosting habitat loss was due to timber harvest
3643 (about 625,600 acres; 14.9%). On nonfederal lands in Oregon and Washington, the extent of older forest
3644 harvested annually declined following implementation of the NWFP. However, this decline was likely
3645 due to exhaustion of the available inventory, as the annual harvest rate stayed relatively steady when
3646 measured as a percentage of the remaining older forest (Healey et al. 2008). A relatively small amount
3647 of nesting and roosting habitat on nonfederal lands was lost to fire, insects, and disease (0.6%; about
3648 23,700 acres).

Comment [LVD94]: 98.Same timeframe uncertainty.

3649 Relative rates of nesting and roosting habitat loss on federal vs. nonfederal lands in California follow the
3650 rangewide pattern. Consistent with the entire subspecies range, loss of nesting and roosting habitat on
3651 federal lands in California was mostly due to wildfire and other natural disturbances (4.2%; 77,500
3652 acres), with a higher rate of loss than on federal lands rangewide (2.8%) (Davis et al. 2011). Most of the
3653 loss to natural disturbance in California occurred in the Klamath Province (73,200 acres), with almost all
3654 of the loss due to wildfire (Davis et al. 2011). Harvest rate of nesting and roosting habitat on federal
3655 lands in California was fairly low and matched that of federal lands rangewide (0.6%; 11,200 acres),
3656 although 3.0% of the nesting and roosting habitat on federal lands in the California Cascades Province
3657 was harvested (6,500 acres), which was the highest rate of harvest on federal lands across all provinces
3658 rangewide (Davis et al. 2011).

Comment [LVD95]: 99.Same issue continues

3659 As with the rangewide pattern, nonfederal lands in California experienced much greater loss of nesting
3660 and roosting habitat to harvest than to natural disturbance. The acreage of nesting and roosting habitat
3661 harvested on non-federal lands in California was about 90,200 acres (5.8%), which exceeds the total
3662 amount of habitat loss on federal lands in California (Davis et al. 2011). This is consistent with the
3663 rangewide pattern showing that the bulk of total nesting and roosting habitat loss has been due to
3664 harvest on nonfederal lands; although the majority occurred in Washington and Oregon, more nesting
3665 and roosting habitat was lost to harvest on non-federal lands (about 625,600 acres) rangewide than
3666 total loss on federal lands from harvest and natural disturbance combined (about 298,600 acres total)
3667 (Davis et al. 2011). California has more nesting and roosting habitat on nonfederal lands than either
3668 Washington or Oregon but has lost relatively less due to harvest, with Washington and Oregon losing
3669 18.6% and 21.8%, respectively, compared to 5.8% in California (Davis et al. 2011). This is likely due to
3670 differences in habitat retention requirements in the regulations of each state. On nonfederal lands in
3671 California, nesting and roosting habitat loss to natural disturbance was relatively low at 0.4% (about
3672 7,500 acres) (Davis et al. 2011).

Comment [LVD96]: 100.Again, this is only looking at acres lost in recent years due to timber harvest, but doesn't account for any of the regrowth. Almost all of the habitat on private timberlands is non-old growth, which means it is a product of regrowth. And, all (or at least the vast majority) of the current NSO sites not in old growth stands are found in stands that were originally clearcut.

Comment [LVD97]: 101.True, but that is mostly because of the regrowth of second and third growth forests.

3673 Davis et al. (2011) estimated amount of dispersal habitat across the range of the Northern Spotted Owl
3674 at the start of the NWFP and at the end of the study period (2006 or 2007 depending on location) by
3675 querying GIS vegetation databases for forests with conifer dbh ≥11 inches and conifer cover ≥40% (see
3676 Figure 5). This is similar to the definition of minimum dispersal habitat from Thomas et al. (1990).
3677 Modeled nesting and roosting habitat was also included in the mapped dispersal habitat because owls
3678 will disperse through forests meeting the requirements of nesting and roosting habitat. Trends in

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dispersal habitat over the study period were analyzed within and between federal reserved lands. The distribution of “dispersal-capable” habitat was also mapped by combining results of the mapped dispersal habitat with estimates of maximum dispersal distance from Forsman et al. (2002) (Figure 17). This estimate of dispersal-capable habitat on the landscape allowed for a measure of the ability of owls to disperse between habitat reserves, which is a goal of the NWFP and an important functional measure of habitat beyond a simple acreage estimate of total dispersal habitat.

Increases in dispersal habitat, as defined by conifer forests exceeding 11 inches dbh and 40% canopy cover, occurred through forest succession and through partial disturbance of nesting and roosting habitat to smaller, more open forest. Recruitment of dispersal habitat exceeded loss rate for a net increase of 5.2% rangewide (Davis et al. 2011). However, given the distribution of habitat increases and losses, the dispersal-capable habitat on the landscape decreased by about 1% (Davis et al. 2011); on federal lands this loss was largely due to wildfire (Figure 18). Losses of dispersal-capable habitat occurred mostly around the periphery of federal forests; Davis et al. (2011) suspect this is due to timber harvesting on nonfederal lands that border federal lands. Gains in dispersal-capable habitat also often occurred at the periphery of federal forests, as forest succession in younger or recently harvested forests led to forests meeting the minimum dispersal requirements.

The network of large federal reserves across the range of the Northern Spotted Owl is fairly well connected, although there are exceptions in the Olympic Peninsula, the eastern Washington Cascades, and in the southern end of the range in California. The Marin County population is poorly connected to other federal reserves, and large portions of the California Coast physiographic province are mapped as having poor dispersal-capability. However, the definition of minimum dispersal habitat in Thomas et al. (1990) and used to map trends in the NWFP may not capture the full range of dispersal habitat conditions in Northern California, where Northern Spotted Owls use younger forests (USFWS 2011a).

Timber Harvest

Timber Harvest on Private Land

The Northern Spotted Owl was federally listed as Threatened in 1990 larger due to extensive habitat loss from timber harvest activities on federal and nonfederal land. In 1991, the California Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] were enacted, which describe options and procedures that can be used in THPs to avoid take of Northern Spotted Owl or to proceed under incidental take authorization. Compliance with the Forest Practice Rules apply to all commercial timber harvesting operations for private landowners (excluding specific exemptions discussed in the Timber Harvest Management section of this report) from small parcels operations to large timber operations. Forest Practice Rules 919.9[939.9] specify subsections (a) through (g), which give the landowner options among which to select and follow for timber harvest within the range of the Northern Spotted Owl.

THPs are plans submitted by the landowners that serve as the environmental review document and they outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment, including impacts to Northern Spotted Owl activity centers. NTMPs are

Comment [LVD98]: 102.Timeframe?

Comment [LVD99]: 103.This is the only recognition that I have seen of the regrowth potential of habitat. If non-habitat can transition into definitions of dispersal habitat, the same thing can and does happen when dispersal or foraging habitat transitions into roosting and nesting habitat.

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3716 plans meant to promote the long term management and planning on forest ownerships of 2,500 acres
3717 or less, and they allow an alternate to submitting individual THPs prior to harvest. Landowners with
3718 approved NTMPs agree to manage their forests through uneven-aged management and long-term
3719 sustained yield.

3720 As detailed in the Timber Harvest Management section of this report, the Department evaluated a
3721 subset of THPs and NTMPs submitted that fell within the range of the Northern Spotted Owl. Evaluation
3722 effort for each plan type varied depending on time constraints and level of information that was readily
3723 available, and included a summary of number of THPs submitted, types of silvicultural methods most
3724 used, and acres of habitat proposed for harvest and retention. For THPs, all plans submitted in 2013
3725 were evaluated, and a subset of Northern Spotted Owl activity centers from plans utilizing Option (e)
3726 and (g) (the most commonly used options from Forest Practice Rules 919.9[939.9]) were followed back
3727 in time to summarize cumulative harvest activities impacting the owl sites. For NTMPs, plans submitted
3728 within interior counties from 1991-2014 were evaluated, and plans submitted within coastal counties
3729 from 2005-2014 were evaluated.

3730 Within the interior THPs evaluated, the Alternative method was proposed more than any other method,
3731 covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total
3732 acreage. An Alternative silvicultural prescription can be included in a timber harvest plan when an
3733 alternative regeneration method or intermediate treatment is more effective or more feasible than any
3734 of the standard silvicultural methods (see Appendix 1). For plans using the Alternative method in the
3735 interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the
3736 Alternative method used. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles
3737 of an activity center, far more area than all other methods combined. Forest Practice Rules Section
3738 913.4(d) defines Variable Retention as an approach to harvesting based on the retention of structural
3739 elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for integration into
3740 the post-harvest stand to achieve various ecological, social and geomorphic objectives (see Appendix 1).

3741 Of the NTMPs evaluated, Selection, Group Selection, and Uneven-aged silvicultural methods are the
3742 most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through
3743 the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection,
3744 Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Uneven-aged
3745 management means the management of a specific forest, with the goal of establishing a well-stocked
3746 stand of various age classes which permits the periodic harvest of individual or small groups of trees to
3747 realize the yield and continually establish a new crop (see Appendix 1). Most NTMPs evaluated that used
3748 the Uneven-aged silvicultural method did not delineate acres that would fall under each category,
3749 therefore there is limited ability to assess the type of harvest applied on the landscape. Under the
3750 Selection and Group Selection methods, the trees are removed individually or in small groups sized
3751 within areas of 0.25 to 2.5 acres.

3752 Types of silvicultural practices vary on the landscape and may impact Northern Spotted Owls differently
3753 depending on a variety of factors surrounding type and extent of habitat removed. For example Clear
3754 Cut harvesting (removal of an entire stand in one harvest), depending on how it is applied on the

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3755 | landscape, has a potential to negatively impact Northern Spotted Owls. However, this same form of
3756 | timber harvesting in the redwood region has been documented to create the greatest abundance of
3757 | dusky-footed woodrats in even-aged stands 5-20 years post-harvest while thinnings did not create
3758 | habitat for this key prey species of the spotted owl (Hamm and Diller 2009). Impacts from harvest have
3759 | been recognized in the literature since the time the owl was federally listed (UFWS 2011a). Yet
3760 | implementation of other frequently used silvicultural methods (e.g., Alternative, Variable Retention,
3761 | Group Selection, Uneven-aged) have less obvious impacts to Northern Spotted Owl foraging, nesting,
3762 | and roosting habitat. Some harvest methods may serve to reduce habitat quality by removing key
3763 | components of owl habitat near Northern Spotted Owls activity centers. For example, thinning has been
3764 | shown to decrease the abundance of Northern Flying Squirrels and Red Tree Voles, two important prey
3765 | species for Northern Spotted Owls (Wilson and Forsman 2013). Alternatively, applied at appropriate
3766 | scales, some methods may in fact serve to enhance owl habitat, for example, by increasing foraging
3767 | opportunities. Given the potential of both negative and positive impacts to the Northern Spotted Owl,
3768 | more thorough documentation and rigorous evaluation monitoring of Spotted Owl responses to of
3769 | harvest type and actual harvest levels of foraging, nesting, and roosting habitat, within harvest plans are
3770 | needed. In addition, research is needed to provide a clearer understanding of the effects of silvicultural
3771 | practices on the regrowth potential of owl habitat including important prey species habitat.

3772 | To evaluate the level of impact of changes that proposed harvest and retention have on to Northern
3773 | Spotted Owl activity centers, each interior and coastal THP utilizing Option (e) and Option (g) in 2013
3774 | within the region was assessed further. Retention and harvest were assessed at two scales for interior
3775 | THPs: within 0.5 miles and between 0.5 and 1.3 miles of an activity center. For coastal THPs, retention
3776 | and harvest was only assessed within 0.7 miles of an activity center. For THPs utilizing Option (e),
3777 | foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles
3778 | and 9,776 acres within 0.5-1.3 miles). On the coast, foraging and nesting/roosting were retained at
3779 | relatively similar levels within 0.7 miles (52,817 acres of foraging and 47,344 acres of nesting and
3780 | roosting). For interior THPs utilizing Option (g) nesting/roosting (1,388 acres within 0.5 miles and 3,879
3781 | acres within 0.5-1.3 miles) and foraging habitat (1,032 acres within 0.5 miles and 3,171 acres within 0.5-
3782 | 1.3 miles) were similarly proposed for retention, and within the coast, more nesting/roosting habitat
3783 | was retained (2,763 within 0.7 miles).

3784 | Timber harvest within the 0.5, 0.7 and 1.3 radii (representing different levels of habitat use by Northern
3785 | Spotted Owls) has a potential to impact quality and extent of owl habitat, and consequently, owl fitness.
3786 | Timber growth is slow, and consequently, regrowth of owl habitat is slow. Therefore, it is important to
3787 | understand the cumulative impact to activity centers over time. As a way of evaluating this impact, the
3788 | amount of habitat proposed for harvest was calculated for activity centers that were associated with
3789 | THPs utilizing Option (e) and Option (g) submitted in 2013 were selected, and harvest history followed
3790 | back in time. Of the 17 activity centers evaluated in the interior, six activity centers have experienced
3791 | greater than 2,000 acres timber harvest cumulatively over time within the 1.3 mile radius (~3,400 acres)
3792 | home range, and six activity centers have experienced greater than 250 acres timber harvest within the
3793 | 0.5 mile radius (~500 acres) core range. Of the 14 activity centers evaluated on the coast, six activity

Comment [LVD100]: 104.Hamm, K. A. and L. V. Diller. 2009. Forest management effects on abundance of woodrats in northern California. *Northwestern Naturalist* 90:97-106.

Comment [LVD101]: 105.I totally agree with this basic concept, except I am not sure what we will learn from "rigorous evaluation." Potentially that means an intensive "paper exercise", which won't provide any real answers. We need timber harvests to be set up in the context of a field experiment with monitoring to determine how NSO respond to various types of amount of timber harvest.

Comment [LVD102]: 106.I would argue that this type of exercise does not get at the level of impact to the species in question. It identifies changes in habitat that occur, but we can only document the impact if those changes are coupled with field studies and monitoring.

Comment [LVD103]: 107."Slow" is relative so I believe you need to provide a range of years for regrowth of various habitats. For example, we know that watershed level liquation of the old growth habitat in the coastal province had regrown and was re-occupied by substantial numbers of NSO in 50-70 years. Now Green Diamond is documenting that clearcut harvesting of the second growth with retention of residual structure is being re-colonized for nesting in 30-40 years. Presumably, that is the fastest in the state, but similar estimates could be derived for other regions by simply looking at when were NSO first documented in various watersheds after the historical logging that eliminated virtually all of the habitat.

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3794 centers experienced harvest of over 500 acres, cumulatively, within the 0.7 mile radius (~985 acres) core
3795 range, with two of these over 1,000 acres (see Table 15, Table 16 and Appendix 3).

3796 Of the interior NTMPs evaluated, 19 (54%) were associated with at least one Northern Spotted Owl
3797 activity center within 1.3 miles of the plan boundary. Of the coastal NTMPs evaluated, 96 (78%) were
3798 associated with at least one activity center within 1.3 miles of the plan boundary. For NTMPs, it was
3799 difficult to assess the extent of harvest and habitat retention because the level of information available,
3800 particularly older plans, was limited in some cases. Considering NTMPs evaluated, we can infer that owl
3801 habitat is retained to some extent; however, we cannot determine the type or quality of habitat
3802 retained. For instance, high quality nesting and roosting habitat may be harvested more frequently,
3803 thereby reducing owl fitness.

3804 Several research studies have demonstrated a link between owl fitness and amount of habitat,
3805 structural characteristics, and spatial configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al.
3806 2005, Irwin et al. 2007, Diller et al. 2010) – see the Habitat Effects on Survival and Reproduction and the
3807 Habitat Loss and Degradation sections of this document. Given what we know about owl habitat and
3808 fitness, it is reasonable to believe that some level of timber harvesting may be beneficial, but too high
3809 levels of harvest, such as levels documented for some activity centers in the harvest analysis described
3810 above, can negatively impact Northern Spotted Owls. In some of the activity centers evaluated for
3811 harvest history, harvest cumulatively exceeded the guidance provided in the Forest Practice Rules
3812 regarding the amount of habitat retention. Furthermore, by comparing territory loss on private timber
3813 lands in the north interior region to USFS lands from 1978-2007 the USFWS (2009) found a 54% decline
3814 in of sites with pairs status to no response became unoccupied and a 23% decline from of the sites with
3815 pair status to became occupied by single owls status on private timber lands, whereas on USFS lands 80%
3816 of the sites did not change pair status. These results suggest inefficiency in rules guiding timber harvest
3817 for the protection of Northern Spotted Owls for the north interior region. In contrast, in the coastal
3818 redwood region, a certain level of even-aged timber harvest in which late seral habitat elements are
3819 retained has been shown to be a critical element in maintaining habitat heterogeneity in the absence of
3820 natural disturbance events such as stand replacing wildfire that historically was responsible for creating
3821 habitat heterogeneity (Diller et al. 2010).

3822 *Harvest of Hardwood Forests*

3823 The economic value of tree species growing on timberlands differs, with conifers being generally more
3824 valuable than hardwoods. The low value of hardwoods historically discouraged their harvest and
3825 removal from timberlands during commercial harvesting (Merenlender et al 1996). The differential
3826 retention of hardwoods coupled with aggressive growth of tanoak during early successional processes
3827 lead many north coast timberlands to be heavily dominated by hardwoods.

3828 To counter this history, the Forest Practice Rules (CCR 912.7, 932.7, and 952.7) provide timber resource
3829 conservation standards that require that the percentage of site occupancy of Group A (generally
3830 conifers) species to not be reduced relative to Group B species (generally hardwoods) as a result of
3831 harvest. The Forest Practice Rules specifically require retention of trees of each native commercial

Comment [LVD104]: 108. I am not as familiar with owls in the interior, but on the coast, it is hard to say if this cumulative harvest is likely to be good for bad for the owls. Green Diamond's and Franklin's habitat fitness models both suggest that about 50% old and 50% young with woodrats ("other" for Franklin but if the other isn't young stands with woodrats it isn't contributing to habitat heterogeneity) maximized habitat fitness for NSO. So if a landscape is largely a sea of similar aged mature second growth, the initial timber harvesting is actually improving the habitat. Only when you go past the 50% does timber harvesting start to have detrimental affects.

Comment [LVD105]: 109. This is confusing to me. A decline in pair status to "no response" (I assume this means unoccupied) means fewer sites became unoccupied, which is a good outcome. It would make more sense to me to just say 54% of the sites with pairs became unoccupied.

Comment [LVD106]: 110. To me, the big unknown for this area is the extent to which habitat heterogeneity is beneficial to owls as has been documented in more coastal areas where woodrats are the key prey species. There is also the issue of the differences in silvicultural practices between the two regions. The interior tends to have very large thinning or some type of uneven aged management. I suspect that this type of silviculture is viewed to have less impact on owls, because there isn't as much change per acre, but because of the size of the harvest units, the cumulative effect is much greater. In addition, thinning or uneven aged management causes much less change to the stand, but does it have any positive effects on the prey base as even aged harvests do in the range of the woodrats?

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species inclusive of Group B hardwoods where present at the time of harvest in a limited number of silvicultural situations: during the seed step of shelterwood (913.1, 933.1, 953.1 (d)(2)(F)) and seed tree (913.1, 933.1, 953.1 (c)(1)(F)) silvicultural systems and only when applied in the absence of a Sustained Yield Plan. The purpose of this retention is to maintain and improve tree species diversity, genetic material and seed production, and is achieved by requiring the leave trees to be of the best phenotypes available. These trees need not be retained during the final, removal step. Otherwise, the Forest Practice Rules relegate hardwood retention during timber harvest to standards developed during plan development and agency review such as “Maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed” (CCR 897(b)(B)), and the “Hardwood Cover” evaluation requirements of the Cumulative Impacts Technical Rule Addendum #2 (CCR 912.9, , 932.9, 952.9 (c)(4)(e).

Outside of the timber harvest regulatory arena, some landowners may be actively suppressing hardwood competition with the more economically valuable conifers. In these situations, the Department has no authority to identify or mitigate impacts by recommending retention standards. Some landowners have developed internal standards that they apply during and outside timber harvest operations. While these may assure specimens and some level of hardwood function are retained on timberlands, the Department is unaware of the empirical support for the efficacy of these levels to provide spotted owl habitat and to support spotted owl forage base.

Regulatory Mechanisms Considerations

Changes in nesting and roosting habitat and dispersal habitat assessed for the NWFP have provided an assessment of broad landscape changes across the range of the Northern Spotted Owl, including changes specific to physiographic regions within California. As has been demonstrated at territory-based studies of habitat in California and southern Oregon, Northern Spotted Owl habitat is composed of a mosaic of mature forests intermixed with younger forest types within the home ranges of individual owls (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007, [Diller et al. 2010](#)), with particular combinations providing high quality habitat. Some of the forest types included in high quality Northern Spotted Owl home ranges are younger forests, which would have been considered foraging habitat in the NWFP modeling, and therefore were not assessed for change in the recent review of the NWFP. Detection of changes in habitat quality at the smaller scale of Northern Spotted Owl home range requires an assessment of management practices at this scale, and can be accomplished by evaluating timber harvest practices around known Northern Spotted Owl activity centers.

For core and home range habitat use, studies have documented a more concentrated and frequent use of habitat features surrounding the activity center (e.g., Hunter et al. 1995, Bingham and Noon 1997, Meyer et al. 1998, Zabel et al. 2003, USFWS 2009). In addition, the shape of core area use varies due to the availability of nesting, roosting and foraging habitat, which deviates from the typical circular representation or core habitat use. The percent of older forest represented within the home range area

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3869 varies from 30-60%, with an average of about 45% (USFWS 2009). For a more detailed discussion on
3870 core and home range use, see Biology and Ecology section of this report.

3871 As discussed in the Habitat Requirements section of this report, certain habitat characteristics have been
3872 shown to support high quality Northern Spotted Owl territories, with both the amount and spatial
3873 configuration of different habitat types at a territory contributing to levels of survival and productivity in
3874 the resident owls. This measure of habitat quality at the scale of Northern Spotted Owl home range has
3875 been termed “habitat fitness potential” (HFP; Franklin et al. 2000). See the Habitat Effects on Survival
3876 and Reproduction section of this report for a discussion of HFP and additional studies that have
3877 contributed to an understanding of habitat characteristics that provide high HFP. The studies that have
3878 evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types
3879 that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent
3880 and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

3881 The definition of take under federal ESA includes actions that would reduce the quality of habitat;
3882 therefore, take avoidance recommendations by the USFWS can provide a reasonable baseline to assess
3883 impacts to habitat quality. Estimation of the likelihood of take according to Section 9 of the ESA would
3884 benefit from a better understanding between habitat quality and owl fitness. When the Forest Practice
3885 Rules were originally created, the criteria for owl habitat and retention were based on the best science
3886 and expert opinion at the time and lacked information on reproduction, survival and occupancy.

3887 The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the
3888 Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls
3889 may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis
3890 conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from
3891 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory
3892 loss. They found on private timber lands there was a 54% decline in pair status to no response, and a
3893 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change
3894 pair status. A lack of owl responses and a lack of suitable habitat to support continued occupancy and
3895 survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early
3896 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat
3897 characteristics to owl fitness, the USFWS asserted that the Forest Practice Rules were insufficient to
3898 adequately avoid take of Northern Spotted Owls (USFWS 2009), although we are not aware of any legal
3899 cases under the current regulatory framework.

3900 To address insufficiencies in the Forest Practice Rules, the USFWS used the results of demography
3901 studies (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005) and additional studies on habitat
3902 selection by Northern Spotted Owl (e.g., Solis and Gutiérrez 1990, Zabel et al. 1993, Irwin et al. 2007), to
3903 develop harvest management guidelines for the interior and coast that would adequately avoid take of
3904 Northern Spotted Owl in California (USFWS 2008b). The purpose of the USFWS guidelines was to enable
3905 CAL FIRE to more effectively and appropriately evaluate THPs and NTMPs to result in timber harvest
3906 activities that do not result in take of owls according to ESA standards. To accompany the guidelines, the
3907 USFWS developed a white paper (USFWS 2009) describing the regulatory and scientific basis for

Comment [LVD107]: 111. Amen to that!
There is also the conundrum that take is focused on avoiding short-term impacts to the individual owl, which may not be beneficial at the population level on the long run. In other words, there could be situations where short terms impacts causing take of an individual may lead to long term benefits to the population

Comment [LVD108]: 112. This same information was included on page 119 above. I would remove the redundancy from above since I think it fits better here.

Comment [LVD109]: 113. Only a single reference, Franklin et al. 2000, was cited in the USFWS 2008 letter. It is the USFWS (2009) white paper that used all the these additional studies.

Comment [LVD110]: 114. This is the paper with the referenced cited above.

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3908 developing the criteria within the guidance for the interior region of California. The USFWS did not
3909 develop a sister document for the coast region in California. Because criteria in the USFWS 2008
3910 guidelines were developed using the most up to date scientific information for habitat effects on owl
3911 fitness within the core and home range areas, the guidelines differ somewhat from the Forest Practice
3912 Rules. Criteria noted in the Forest Practice Rules Section 919.9 subdivision (g) and the USFWS 2008 and
3913 2009 guidelines are summarized in Tables 20, 21 and 22 below. Definitions of owl habitat referred to in
3914 Forest Practice Rules Section 919.9(g) can be found in Appendix 2.

3915 Among the recommendations in the USFWS guidance to CAL FIRE (USFWS 2008b), minimum amounts of
3916 nesting, roosting, and foraging habitat are described for both 0.5 mile (502 acres; interior forests) and
3917 0.7 mile (985 acres; coastal forests) radius surrounding the activity center, representing the core habitat
3918 use, and for an outer ring of habitat from 0.5 to 1.3 miles radius (2,908 acres; interior forests)
3919 surrounding the activity center, representing broader home range. The USFWS determined that within
3920 the interior forests in California, 0.5 mile radius, rather than the 0.7 mile radius noted in the Forest
3921 Practice Rules, more effectively captured actual core habitat use of Northern Spotted Owls (USFWS
3922 2009). The 2008 USFWS guidelines also revised the definitions of nesting, roosting, and foraging habitat
3923 for the interior, and included differentiation between high quality and low quality habitat (USFWS 2008b
3924 and USFWS 2009). Although assumptions were required in order to develop a single set of guidelines for
3925 the interior forests, the amount and spatial configuration of habitat to be retained is consistent with
3926 what was found in studies that evaluated habitat quality as a function of owl fitness.

3927 When the Northern Spotted Owl guidelines were added to the Forest Practice Rules in 1992, the intent
3928 was to protect Northern Spotted Owls and suitable habitat used for nesting, roosting and foraging. Since
3929 that time, additional scientific literature (e.g., Franklin et al. 2000, Irwin et al. 2000, Zabel et al. 2003,
3930 Courtney et al. 2004, Dugger et al. 2005, Glen et al. 2004, Olson et al. 2004, Irwin et al. 2007, [Diller et al.
2010](#)) has been published that helps to further elucidate habitat use of Spotted Owls and associations
3932 between habitat and owl fitness. It is also known that [detection response](#) and occupancy rates have
3933 declined at [some historical activity centers](#) [many study areas](#). Though [the specific reasons why Barred
Owls have been shown to negatively influence response-detection](#) and occupancy rates (Pearson and
3934 Livezy 2003, Gremel 2005, Olson et al. 2005, Crozier et al. 2006 Kroll et al. 2010, Dugger et al. 2009,
3935 Dugger et al. 2011, Wiens et al. 2011) have declined are unknown, there are multiple likely factors
3936 including cumulative habitat loss and degradation [that influences occupancy rates, and presence of
Barred Owl](#). Given this broad range of possibilities, the Forest Practice Rules may not be sufficient at
3937 protecting loss of Northern Spotted Owl habitat within its range in California.

3940 **Table 20.** Criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted
3941 Owls on private timberlands according to Forest Practice Rules Section 919.9(g).

Forest Practice Rules Subsection	Proximity to Activity Center (acreage)	Criteria Description
919.9(g)(1)	Within 500 feet of the activity center (~18 acres)	Characteristics of functional nesting habitat must be retained.
919.9(g)(2)	Within 500-1000 feet of the activity center (1,000 foot radius)	Retain sufficient functional characteristics to support roosting and provide protection from predation and

Comment [LVD111]: 115.I think we know enough to say with certainty that reduced detection rates have generally been caused by barred owls (Dugger et al. 2009, Olson et al. 2005, Crozier et al. 2006, and Wiens et al. 2011). Declines in occupancy have also been documented to be caused by barred owls, but of course, habitat could as well. These two parameters are certainly related, but responsiveness influences detection probabilities, but if properly modeled, not occupancy rates.

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	circle is ~72 acres)	storms.
919.9(g)(3)	Within a 0.7 mile radius of the activity center (~985 acres)	Provide 500 acres of owl habitat. The 500 acres includes the habitat retained in subsections 919.9(g)(1) and (2) and should be as contiguous as possible.
919.9(g)(4)	Within 1.3 miles of each activity center (~3,400 acres)	Provide 1,336 total acres of owl habitat. The 1,336 acres includes the habitat retained within subsections 919.9(g)(1)-(3).
919.9(g)(5)	Shape of habitat retention	Areas established shall be adjusted to conform to natural landscape attributes such as draws and stream courses while retaining the total area required within subsections 919.9(g)(1) and (2).

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3943 **Table 21.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of
3944 Northern Spotted Owls on private timberlands, and selected stand structural parameters used to classify
3945 nesting/roosting and foraging habitat for Northern Spotted Owls in the northern coastal region of California
3946 (USFWS 2008b).

Habitat Type	Acre Retention in Core Area (within 0.7 mile; ~985 acres) ¹	Acre Retention in Outer Ring (between 0.7-1.3 mile) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	DBH	Percent Canopy Cover	Basal Area
Nesting/Roosting	200 acres	NA	200 acres	≥ 11 inch	≥ 60%	≥ 100 ft ² /acre
Foraging	≥ 300 acres	NA	≥ 300 acres	≥ 11 inch	≥ 40%	≥ 75 ft ² /acre
Suitable Habitat ²	NA	≥ 836 acres	≥ 836 acres			

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¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the plan.

² Suitable Habitat is defined as habitat that meets either Nesting/Roosting or Foraging definitions, or a combination of Nesting/Roosting and Foraging habitat.

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3951 **Table 22.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted Owls on private timberlands,
3952 and selected stand structural parameters used to classify nesting/roosting and foraging habitat for Northern Spotted Owls in the northern interior region of
3953 California (USFWS 2008b and 2009).

Habitat Type	Within 1,000 feet of Activity Center	Acre Retention in Core Area (within 0.5 mile; ~500 acres) ¹	Acre Retention in Outer Ring (between 0.5-1.3 mile; ~2,900 acres) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	Basal Area Parameter	Quadratic Mean Diameter Parameter	Large trees/acre Parameter	Canopy Closure Parameter
High Quality Nesting/Roosting	No timber operations are allowed other than use of existing roads.	100 acres	NA	100 acres	≥ 210 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Nesting/Roosting		150 acres	NA	150 acres	Mix, ranging from 150 to ≥ 180 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Foraging		100 acres	655 acres	755 acres	Mix, ranging from 120 to ≥ 180 ft ² /acre	≥ 13 inch	≥ 5	≥ 40%
Low-quality Foraging		50 acres	280 acres	330 acres	Mix, ranging from 80 to ≥ 120 ft ² /acre	≥ 11 inch	NA	≥ 40%

3954 ¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the plan.
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A comparison of the habitat definitions and retention requirements in Section 919.9(g) of the Forest Practice Rules (Appendix 2 and Table 20) and the revised take avoidance guidance provided by the USFWS (2009; summarized in Table 21 and 22) reveals how implementation of the Forest Practice Rules, as written, may result in degradation of habitat quality around Spotted Owl activity centers in the interior portion of the range. The definition of functional nesting habitat under the Forest Practice Rules might be adequate to provide suitable nesting or roosting habitat for spotted owls, although the average stem diameter is less than that recommended by the USFWS. The functional roosting habitat under Forest Practice Rules does not meet the requirements of roosting habitat under the USFWS recommendation; habitat falling under the roosting habitat definition would be considered low-quality foraging habitat under the USFWS recommendations. Functional foraging habitat as defined under Forest Practice Rules might meet the requirements for low-quality foraging habitat as defined by USFWS, but does not meet the requirements of foraging habitat.

Under the Forest Practice Rules minimum retention requirements, stands that meet the USFWS recommendation for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres). The habitat retained within 1,000 feet (~72 acres) would be defined as low-quality foraging habitat in the USFWS guidance. Because the 500 acres of spotted owl habitat to be retained within 0.7 miles and the total of 1,336 acres to be retained within 1.3 miles of an activity center can be composed of functional foraging habitat, there is no requirement in the Forest Practice Rules for the retained habitat within 0.7 or 1.3 miles of the activity center to include nesting or roosting habitat. Also, using the revised habitat definitions provided by USFWS (2009), this retained foraging habitat could be of low quality. Although similar acreage of habitat is retained under the Forest Practice Rules and the USFWS recommendations, very little of the habitat retained under Forest Practice Rules is required to meet the requirements of nesting or roosting habitat. Consequently, depending on how the rules are implemented, management could result in a reduction in habitat quality around Northern Spotted Owl sites and could lead to declines in survival, productivity, and overall fitness.

Habitat Loss from Marijuana Cultivation

Large-scale marijuana cultivation in remote forests throughout California has increased since the mid-1990s, coinciding the time the “Compassionate Use Act” was passed in 1996 (Proposition 215) that allows the legal use and growth of marijuana for certain medical purposes (Bauer et al. 2015). Within the range of the Northern Spotted Owl, Shasta, Tehama, Humboldt, Mendocino, and Trinity counties comprise the areas known for the most marijuana cultivation in California due to the remote and rugged nature of the land, making cultivation difficult to detect (National Drug Intelligence Center 2007, Bauer et al. 2015). Illegal marijuana cultivation grows on public and private land are widespread in California (Gabriel et al. 2013, Thompson et al. 2013, Office of National Drug Control Policy 2015), and may also negatively impact owl habitat through degradation and removal, though data on the extent of this impact is not well known. The Office of National Drug Control Policy (2015) reported that in 2012 3.6 million plants were eradicated from 5,000 illegal outdoor marijuana grow sites in the United States, of which 43% were removed from public and tribal lands. Additionally, the USFS reported that 83% of the plants removed were from California (Office of National Drug Control Policy 2015). Areas with higher

Comment [LVD112]: 116. In my opinion, what is missing in these habitat definitions relative to FPRs and FWS guidelines is the spatial component, which has been shown to be potentially the most important element at least in some regions of the NSO's range (Franklin et al. 2000, Diller et al. 2010). In addition, foraging habitat is defined in terms of the trees and which may have very little to do with the amount and availability of prey.

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3995 prevalence of marijuana cultivation may also contain high numbers of Northern Spotted Owl activity
3996 centers (see Figure 3), especially in areas where riparian habitat exists.

3997 As discussed previously, for typical timber harvest activities, land owners are bound by the Forest
3998 Practice Rules and would therefore need to submit a THP, Spotted Owl Management Plan, Spotted Owl
3999 Resource Plan or exemption notification to the appropriate governing agencies. However, small scale
4000 timber removal in association with legal marijuana cultivation on private land does not require review or
4001 approval from state or federal governments as long as the timber is not sold. Habitat alteration also
4002 occurs in association with illegal marijuana grow sites, but the extent is not well known due to the
4003 secretive nature of these activities. Therefore, loss of timber and other habitat components important
4004 to Northern Spotted Owls (e.g., riparian habitat alterations) for the cultivation of marijuana for such
4005 purposes is largely unregulated.

4006 To date, there has been no study that analyzes the impact of marijuana cultivation sites on Northern
4007 Spotted Owl habitat or fitness. However, there is a potential for negative impacts of sites placed on
4008 private and public land within the owl's range. The level of impact would likely depend on density of
4009 cultivation sites in proximity to owl activity centers, and whether sites are placed within suitable owl
4010 habitat.

4011 In an effort to assess potential environmental impacts to aquatic ecosystems from legal marijuana
4012 cultivation, Bauer et al. (2015) delineated cultivation sites (outdoor plantations and greenhouse
4013 locations), using Google Earth satellite imagery from 2011 and 2012, within four watersheds (hereafter
4014 referred to as the study area): Upper Redwood Creek, Redwood Creek South, and Salmon Creek, located
4015 in Humboldt County; and Outlet Creek, located in Mendocino County. In addition to the Bauer et al.
4016 (2015) study area, cultivation sites in the Mad River Creek watershed, in Mendocino and Trinity
4017 counties, were also delineated due to interest in identifying potential impacts to aquatic species and
4018 water quality in that area. Cumulatively, these 5 watersheds represent approximately 4% of the
4019 Northern Spotted Owl range in California (Table 23). Within these watersheds, marijuana cultivation
4020 sites varied in size from 0.002 to 2.9 acres and comprised a total of 362 acres. This is a relatively small
4021 portion of the watersheds assessed.

4022 **Table 23.** The number of marijuana cultivation sites within each watershed, and area (acres) associated with each.
4023 Watersheds assessed are within Humboldt, Mendocino, and Trinity counties.

Watershed Name	Area (acres)	No. of Cultivation Sites	Total area (acres) of Cultivation Sites
Upper Redwood Creek	155,338	253	43
Redwood Creek South	16,653	369	53
Salmon Creek	23,489	515	42
Outlet Creek	103,554	795	90
Mad River Creek	321,972	416	134

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To assess potential impacts to Northern Spotted Owls we assessed marijuana cultivation locations from 2011 and 2012 within the watersheds mentioned in Table 23, together with owl activity centers locations (Figure 19). We found that no activity centers were within delineated cultivation sites; however, 10 activity centers are within 0.5 miles of the cultivation sites, and 96 within 1.3 miles. Depending on the size of the site and how much suitable owl habitat is removed, impacts to owls may vary. The amount and type of owl habitat removed is summarized in Table 24. For the cultivation sites delineated in 2011 and 2012, much of the habitat removed was unsuitable for Northern Spotted Owls, with the exception of Mad River Creek watershed; here, 12.45 acres of highly suitable, 6.89 acres of suitable, and 22.91 acres of marginal owl habitat was removed.

Table 24. Level of owl habitat removed in each watershed. *(Need to include the units in this table)*

Watershed Name	Highly Suitable	Suitable	Marginal	Unsuitable
Upper Redwood Creek	2.67	3.56	22.91	8.9
Redwood Creek South	1.11	1.33	14.90	32.47
Salmon Creek	0.00	0.89	12.23	20.68
Outlet Creek	3.56	5.56	15.35	38.25
Mad River Creek	12.45	6.89	22.91	8.90

As described elsewhere in this report, habitat removal, fragmentation, and degradation can all have varying degrees of negative impacts on spotted owls depending on how much suitable habitat is removed within their core range (e.g., represented by the 0.5 mile buffer surrounding the activity center) and within their home range (e.g., represented by the 1.3 mile buffer surrounding the activity center). Of the 362 acres of forestland or riparian habitat removed for marijuana cultivation, approximately 20 acres are within highly suitable Northern Spotted Owl habitat, 18 acres are in suitable habitat, and 97 acres are in marginal habitat. As an example of potential impacts to Northern Spotted Owl activity centers, Figure 20 shows a zoomed in area in Humboldt County where marijuana cultivation sites overlap the home range for several activity centers. One activity center displayed in Figure 20 experienced removal of 4.45 acres of highly suitable habitat, 0.67 acres of suitable, 4.45 acres of marginal, and 0.89 acres of unsuitable habitat within the 1.3 mile buffer.

The data used for this analysis comes with certain limitations when assessing long-term impacts to the Northern Spotted Owl. First, the dataset is a snapshot in time during 2011 and 2012 and does not represent expansion of cultivation sites since the data were collected. The data also only covers 4% of the Northern Spotted Owl range and therefore is only representing a small area of potential impact. Marijuana cultivation is occurring outside of the area assessed. To more fully consider impacts a similar analysis would have to be done within the entire range. In addition, smaller clearings (less than 10 mi²) are likely not captured in the dataset due to difficulties identifying and delineating smaller sites using aerial imagery and not all sites locations are reported as required by law. Sites likely have not been captured for other reasons as well; for example, some sites are intentionally placed in areas where they are harder to detect (e.g., sites with higher canopy closure). Law enforcement efforts and ground truthing helped fill in the gaps for the data collected in 2011 and 2012, but it is still uncertain how many

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sites were not accounted for. Lastly, there may be other activities associated with the cultivation sites not captured using this data that can also have an impact in owl, such as placement of roads and vehicular traffic.

Given above uncertainties regarding the dataset used in this analysis, it is plausible to assume that the density of cultivation sites is likely higher than represented in the dataset. In addition, given the density of cultivation sites within Humboldt, Trinity and Mendocino counties represented in this analysis, and the fact that the watersheds analyzed comprise only 4% of the Northern Spotted Owl range, it is also very plausible to assume that marijuana cultivation sites are impacting spotted owl habitat, thereby likely impacting fitness to some extent. While indirect impacts to spotted owls through modification or loss of habitat loss may be minimal, the potential direct impacts from anticoagulant rodenticides (ARs) use associated with marijuana cultivation may be much more serious (see Contaminants section below).

Wildfire

Effect of Wildfire and Salvage Logging

Wildfire is a natural process in California's forests, and in much of its range the Northern Spotted Owl has evolved in a landscape of frequent wildfire. Despite this, fire is often considered a primary threat to Northern Spotted Owl habitat due the owl's preference for older forests and the capacity of fire to rapidly remove or degrade habitat. The mature forests preferred by owls for nesting and roosting can take decades to centuries to develop following removal, depending on location and forest type and fire severity. The USFWS revised recovery plan (USFWS 2011) considered fire to be a primary threat to the Northern Spotted Owl in some fire-prone physiographic provinces, along with ongoing losses to timber harvest and competition with the Barred Owl. As discussed above, fire has become the primary cause of nesting and roosting habitat loss on federal lands since implementation of the NWFP, only surpassed by rangewide losses due to timber harvest, which have been concentrated on nonfederal land (Davis et al. 2011).

The majority of the natural disturbance loss (e.g., disease, insects, wildfires) of nesting and roosting habitat on federal lands since 1994 has occurred in the five relatively dry physiographic provinces (eastern Washington, eastern Oregon, and California Cascades; Oregon and California Klamath; Figure 21), with about 86% (211,300 acres) of the natural disturbance loss occurring in these provinces (Davis et al. 2011).

These dry provinces contain only about 42% of the total nesting and roosting habitat acreage on federal lands rangewide. Most habitat loss in the dry provinces was due to wildfire in the Oregon and California Klamath and the eastern Washington and eastern Oregon Cascades (Davis et al. 2011). Degradation of nesting and roosting habitat from fire was also estimated, with most degradation occurring in the western Cascades (Davis et al. 2011).

Research on the effect of wildfire on Spotted Owl habitat use and selection, occupancy, and survival has been conducted throughout the range of the species from eastern Washington and southern Oregon, in

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4094 the Sierra Nevada mountains in the range of the California Spotted Owl, and in Arizona and New Mexico
4095 in the range of the Mexican Spotted Owl (e.g., Gaines et al. 1997, Bond et al. 2002, Jenness et al. 2004,
4096 Bond et al. 2009, Clark et al. 2011, 2013). Studies to date are scattered throughout the range of the
4097 Spotted Owl and have generally been performed opportunistically due to the difficulties associated with
4098 experimental fire research in a natural setting; much uncertainty remains on the effect of wildfires on
4099 the extent and quality of Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates
4100 by Spotted Owls have been somewhat equivocal, in some cases showing that stand replacing wildfire
4101 has a negative impact on occupancy (e.g., Gaines et al. 1997), and in other cases showing no adverse
4102 impact of wildfire on Spotted Owl occupancy (e.g., Jenness et al. 2004). Here we focus on the relatively
4103 extensive studies from the Sierra Nevada Mountains in the range of the California Spotted Owl and from
4104 southwestern Oregon in the range of the Northern Spotted Owl, as these areas more closely represent
4105 the forest types within the interior range of the Northern Spotted Owl in California and are relatively
4106 well studied.

4107 In the southern Sierra Nevada, in areas with a mosaic of burned and unburned forests, California
4108 Spotted Owls have been shown to use forests that have experienced a full range of burn severities. Bond
4109 et al. (2009) found the degree to which a post-fire site was used varied with burn severity and with the
4110 function of the site in meeting various life history requirements (i.e., nesting, roosting, or foraging). This
4111 study occurred in an area that experienced the full range of burn severities, resulting in owl territories
4112 with a mosaic of all burn classes, ranging from unburned forests to areas with most of the overstory
4113 removed by fire (high-severity burn areas were defined as those resulting in high to complete mortality
4114 of dominant vegetation; low-severity burn areas were defined as those with little change in cover and
4115 little tree mortality; moderate-severity burn areas were those between high- and low-severity, with a
4116 mixture of effects on vegetation). Most California Spotted Owl roost sites (85%) occurred in unburned
4117 and low-severity burn areas, and owls avoided roosting in moderately and severely burned areas.
4118 Conversely, California Spotted Owls selected foraging sites represented by all severities of burned forest
4119 and avoided unburned forest (Bond et al. 2009). This study illustrated that California Spotted Owls use
4120 multiple forest types within a home range to meet nesting, roosting, and foraging needs, and that
4121 moderate to high severity fires may impact preferred nesting and roosting habitat while providing
4122 foraging habitat. In contrast to the findings of Bond et al. (2009), recent work on the impact of fire on
4123 foraging site selection by California Spotted Owls in Yosemite National Park showed that owls selected
4124 for areas of low-severity burns but avoided areas of high-severity burns (Eyes 2014). The owls that were
4125 tracked in the burned areas of the southern Sierra Nevada (Bond et al. 2009) were shown to have a diet
4126 composed of predominately pocket gophers (Bond et al. 2013), whereas the diet of California Spotted
4127 Owls in unburned forests was dominated by woodrats and northern flying squirrels, depending on
4128 location. Breeding home range sizes were similar for owls occupying burned and unburned areas (Bond
4129 et al. 2013). The apparent shift to an alternative prey source in the post-fire landscape of the Sierra
4130 Nevada may have allowed California Spotted Owls to effectively utilize high-severity burn areas and to
4131 maintain similar home range sizes.

4132 The use of a diverse forest composition in the Sierra Nevada is consistent with research conducted in
4133 the range of the Northern Spotted Owl that indicate high quality habitat is composed of older more

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mature forest among a mosaic of other forest types (Franklin et al. 2000, Olson et al. 2004, [Diller et al. 2010](#)). California Spotted Owls in the Sierra Nevada also selected for foraging sites that included edge between burned and unburned forests and between burn areas of different severity classes (Bond et al. 2009). This is consistent with the above studies on Northern Spotted Owls which showed high quality habitat to have high amounts of edge between old forests and other forest types.

In a study of post-fire occupancy at six fire sites across the range of the California Spotted Owl in the Sierra Nevada, Lee et al. (2012) found no difference in occupancy rates between burned and unburned sites. As with the above study on post-fire habitat selection, this study included fires with a range of burn severities, which is typical of fires in the Sierra Nevada (Odion and Hanson 2006). Of the six fires included in the study, on average 32% of the burned area was burned at high-severity so these results are applicable to mixed-severity fires that result in a mosaic of post-fire conditions. A subset of burned sites included in the study (9 of 41) burned at higher severity (>50% high severity burn of suitable owl habitat). Owls were detected at five of these nine sites post-fire (Lee et al. 2012), suggesting that sites that were exposed to higher amounts of high-severity fire might have experienced reductions in occupancy, but this was not modeled. Salvage logging of timber after a fire was known to occur on eight burned sites post-fire. California Spotted Owls initially occupied seven of the eight sites after the fire, but following the salvage logging none of the sites remained occupied. Post-fire logging may have adversely affected occupancy of burned sites but the sample size was too small for the effect to be modeled (Lee et al. 2012). An additional study in the Sierra Nevada compared occupancy rates at 10 unburned sites to 9 sites that burned at low to moderate severity in Yosemite National Park and found no difference in occupancy rates between burned and unburned sites (Roberts et al. 2011). The study area was restricted to areas with $\geq 40\%$ canopy cover, and occupancy was positively correlated with total tree basal area and canopy closure (Roberts et al. 2011). This study did not address effects of high-severity fire, nor post-fire logging.

In the range of the Northern Spotted Owl, the most extensive evaluation of the effect of fire on owls has been conducted on a group of three fires in the Klamath and Western Cascades physiographic provinces of southwest Oregon (Clark 2007, Clark et al. 2011, 2013). By tracking radio-marked owls with territories inside and adjacent to burned areas, Clark et al. (2011) were able to estimate the effects of fire on occupancy and survival of Northern Spotted Owls. The occurrence of a demographic study area (South Cascades) in proximity to the fires allowed for comparison of unburned areas to pre- and post-fire rates within the fire footprints. On one of the fire study areas (Timbered Rock fire), 22 territories had been surveyed for ten years pre-fire and so allowed for a comparison of pre- and post-fire occupancy. Occupancy at this site was compared to the nearby South Cascades study area and the two areas were shown to have similar trends in occupancy rates prior to the Timbered Rock fire in 2002. However, extinction rates in the Timbered Rock fire area increased after the fire, resulting in declines in occupancy (Clark 2007, Clark et al. 2013). Only 20% of territories at the Timbered Rock fire were occupied by a pair of owls by the end of the study period in 2006 (four years post fire), where >50% of territories had been occupied in all years pre-fire. These declines were not observed at the unburned South Cascades study area. Data collected at all three fires from 2003-2006 was used to model post-fire rates and suggested that high extinction rates and low colonization rates led to declines in post-fire occupancy (Clark 2007).

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4174 On two of the burned areas in southwest Oregon (Timbered Rock and Quartz fires), 23 radio-marked
4175 Northern Spotted Owls were tracked over a one year period in order to estimate survival rates of owls
4176 within and adjacent to burns. Mean annual survival rates of owls displaced by wildfire (0.66 ± 0.14) or
4177 occupying territories within the burned area (0.69 ± 0.12) were lower than those for owls outside of
4178 burned areas (0.85 ± 0.06) (Clark et al. 2011). Survival rates of owls outside of burned areas were similar
4179 to rates at the nearby unburned demographic study area (South Cascades; 0.85 ± 0.01) (Anthony et al.
4180 2006). The two fires included in the survival study each burned about 50% of the owl habitat at mixed
4181 severities from low to high, which is comparable to fires included in studies on California Spotted Owl in
4182 the Sierra Nevada. Of the 24 owls tracked, 5 died during the study. Necropsies were performed on 4 of
4183 these owls and showed that all were severely emaciated and likely died due to starvation (Clark et al.
4184 2011). This, and the fact that owls in the study maintained larger home ranges post-fire (Clark 2007),
4185 suggest that food limitation might have played a role in reduced survival rates. Also, the documented
4186 dispersal of several adult Northern Spotted Owls out of the burn area at the Timbered Rock fire 1-2
4187 years post-fire suggests that insufficient habitat remained at abandoned territories to support an owl
4188 pair (Clark et al. 2013). Both of the fire areas in this study were salvaged logged post-fire, with about
4189 20% of the area logged in each fire. See discussion on potential effects of salvage logging below.

4190 Using the telemetry data collected by Clark in southwest Oregon, Comfort (2013) evaluated selection of
4191 habitats relative to availability following mixed-severity fire disturbance. The strongest predictor of
4192 spotted owl presence was habitat suitability (as defined in the 10-year review of the Northwest Forest
4193 Plan (Davis and Lint 2005)). Northern Spotted Owls avoided large, contiguous patches of high-severity
4194 disturbance and preferentially used areas of lower severity disturbance (Comfort 2013). At small spatial
4195 scales (<0.8 ha), Spotted Owls did select for areas with hard edge created by high severity fire, but at
4196 larger spatial scales, hard edges were avoided. This suggests that at the scale of a home range, owls
4197 selected for large patches of contiguous high suitability habitat interspersed with small patches (<0.8 ha)
4198 of high severity fire or salvage logging (Comfort 2013). Because salvage logging occurred in the study
4199 area on private industry land, the analysis by Comfort did not distinguish between areas of high-severity
4200 burns and those that were salvage logged, but instead used the combined disturbance of fire and
4201 logging to evaluate owl use of different components of the landscape.

4202 An earlier study evaluated short term survival of Spotted Owls following wildfire by tracking color-
4203 banded owls which occurred on territories that later burned in a wildfire during a period from 1985-
4204 2001 (Bond et al. 2002). Because of the opportunistic nature of observations for this study, only 11
4205 territories were included in the study and they were distributed across the range of the species from
4206 California, Arizona, and New Mexico, and represented all three subspecies of the Spotted Owl. Twenty-
4207 one color-banded owls had occurred on the eleven territories pre-fire and 18 were resighted the year
4208 following fire (Bond et al. 2002). This represents a simple annual survival estimate of 86%, which is
4209 similar to reported estimates of survival in unburned areas. The short-term covered by the study (one
4210 year post-fire) and the small sample size limit the utility of the study in extrapolating to a general effect
4211 of fire on Northern Spotted Owls (of which four territories were included), but they do at least
4212 demonstrate that some wildfires have little short-term impact on Spotted Owl survival. Most territories

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4213 in this study burned at low to moderate severity and no salvage logging had occurred between time of
4214 fire and the following year when resighting attempts occurred (Bond et al. 2002).

4215 Post-fire declines in occupancy in southern Oregon contrast with most results for the California Spotted
4216 Owl in the Sierra Nevada. As mentioned above, two of three burn areas in southern Oregon underwent
4217 fairly extensive salvage logging post-fire. The studies conducted in the Sierra Nevada included some sites
4218 that were salvage logged, but sample sizes were too small to model the perceived effect of logging on
4219 occupancy. Several authors have suggested that salvage logging after a fire or occurrence of extensive
4220 high severity burns likely have contributed to a decline in habitat use, occupancy, or survival of Northern
4221 Spotted Owls (Bond et al. 2009, Roberts et al. 2011, Clark et al. 2011, 2013, Lee et al. 2012). With the
4222 exception of low severity burns, burned areas have generally not supported nesting habitat but have
4223 been shown in some cases to create foraging habitat. The presence of snags has been suggested as an
4224 important component of prey habitat and as perch sites for foraging Spotted Owls. We do not know of
4225 any research conducted on Northern Spotted Owl prey abundance in burned vs. unburned forests, but
4226 early successional forests have been shown to support abundant woodrat populations in the southern
4227 portion of the range (see discussion of prey in Life History section) and so burned areas may provide
4228 high quality prey habitat once vegetation regrowth produces an understory. Bond et al. (2009)
4229 concluded that the most likely explanation for high probability of use by foraging California Spotted
4230 Owls of forest patches that experienced high severity burns was increased prey promulgated by
4231 enhanced habitat conditions, including increased shrub and herbaceous cover and number of snags, and
4232 provided the following discussion on the importance of snags to Spotted Owl prey:

4233 “Snags provide shelters for prey species like woodrats and flying squirrels. In the southern Sierra
4234 Nevada, dusky-footed woodrat nests are common where shrubs encircle rock outcrops or snags
4235 (Lawrence 1966). Bushy-tailed woodrat (*N. cinerea*) densities in dry forests of eastern
4236 Washington, USA, were strongly correlated with arboreal and terrestrial cover in the form of
4237 large snags, mistletoe, and large soft logs (Lehmkuhl et al. 2006). Northern flying squirrel
4238 population densities in Oregon, USA, were correlated with the occurrence of suitable nesting
4239 cavities in trees and early decay-stage snags with diameters >50 cm (Volz 1986).”

4240 Lee et al. (2012) argued that snags play an important role in suitable California Spotted Owl habitat in
4241 burned areas. This was based on observations that occupancy decreased when ≥20 ha of mature conifer
4242 forest was logged within a 400-ha circle surrounding a California Spotted Owl site (Seamans and
4243 Gutiérrez 2007), whereas when an average of 32% of suitable habitat within a 400-ha circle burned at
4244 high severity no negative effect on occupancy is observed. In southern Oregon, Clark et al. (2013)
4245 modeled the effects of fire severity, salvage logging, and pre-fire habitat characteristics on occupancy by
4246 Northern Spotted Owls. They found that extinction probabilities increased as the combined area of pre-
4247 fire harvest, high-severity burn, or salvage logging increased, resulting in reduced occupancy of nesting
4248 territories by Northern Spotted Owls; however, they were unable to distinguish the effect of salvage
4249 logging from the other effects (i.e. these factors collectively contributed to declines in occupancy).
4250 Observational studies and occupancy modeling conducted to date suggest that post-fire landscapes that
4251 are salvage logged experience declines in Spotted Owl occupancy. However, other factors such as initial
4252 habitat conditions (e.g., area of pre-fire harvest), the amount and distribution of high-severity fire,

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regional differences in forest composition and fire history, and differential subspecies response may also influence occupancy. Based on results to date that suggest an impact of salvage logging, Bond et al. (2009) recommended that burned forests within 1.5 km of nests or roosts of California Spotted Owls not be salvage logged and Clark et al. recommended restricting salvage logging after fires within 2.2 km of Spotted Owl territories in the range of the Northern Spotted Owl in southern Oregon.

Fire Regime in the Northern Spotted Owl Range

When the USFWS subdivided the range of the Northern Spotted Owl into 12 physiographic provinces, information on fire disturbance regimes was used to inform boundaries (USFWS 1992). Efforts to map the fire-prone portion of the Northern Spotted Owl range since then have generally followed physiographic province boundaries, with the drier provinces of the eastern and California cascades and the Oregon and California Klamath provinces generally considered more fire-prone (e.g., see Rapp 2005, Spies et al. 2006, and Healey et al. 2008). As part of an evaluation of the NWFP, a recent effort to model fire-prone areas used fire history and environmental predictor variables to map the likelihood of large wildfire occurrence throughout the range (Davis et al. 2011). Although this approach did not use existing physiographic province boundaries or other lines used to delineate fire-regimes across the Northern Spotted Owl range to inform the model, results are generally similar to previous descriptions based on broad geographic regions (Figure 22(a)). See Davis et al. (2011) for discussion and potential explanation of differences between model results and previous predictions of fire-prone regions in the eastern and western Oregon Cascades.

Regardless of methodology used, all attempts to map fire-prone areas consistently include large portions of the Northern Spotted Owl range in California, with much of the California Klamath and California Cascades highly prone to fire disturbance. By overlaying the modeling results for fire-prone areas with the Northern Spotted Owl habitat suitability map, Davis et al. (2011) showed that the physiographic province with the most owl nesting and roosting habitat in fire-prone landscapes is the California Klamath Province. This is evident when looking at actual fire history from 1950 to 2013 (Figure 22(b)). Over the last several decades, large acreage fires have been prevalent on the landscape within the Klamath Province.

Within the fire-prone regions of California, fire regimes vary depending on a number of factors, with broad differences noted between the mixed conifer/mixed hardwood forests characteristic of the Klamath Province and the ponderosa pine forests that dominate some portions of the Cascade Province and eastern Klamath Province. The following discussion of historical and current fire regimes in California focuses on these two provinces, as these are the two regions where fire is most likely to have an impact on the Northern Spotted Owl.

Historical Fire Regime in the Klamath Province

As described in the Habitat section of this report, the Klamath Province is an area with extremely high floristic diversity and heterogeneity. This diversity arises from complex patterns in topography, soils, and climate throughout the region, which results in complex vegetation and contributes to a diverse fire

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regime. The natural fire regime acts in a positive feedback manner to contribute to vegetation heterogeneity and diversity (Odion et al. 2004, Skinner et al. 2006). The dominant conifer species across most of the low and mid-elevations in the Klamath Province is the Douglas-fir, and depending on local conditions a wide variety of conifer species may co-occur with this dominant species. At higher elevations, the dominant conifer grades into white fir, and at the highest elevations, a diverse set of subalpine conifer species can occur. Low and mid elevations are characterized by an equally diverse set of hardwood species that form lower canopy layers of mixed conifer hardwood forests and can also occur as pure stands. This occurrence of diverse hardwoods in coniferous forests of the Klamath region may reduce fire severity, and following fire may lead to more rapid recovery by sprouting (Odion et al. 2004, Spies et al. 2006). In drier eastern portions of the Klamath Province, ponderosa pine can be the dominant or co-dominant conifer. Because of the greater extent of ponderosa pine-dominated forests in the California Cascade Province, this forest type is discussed below.

Throughout the Klamath Mountains in the presettlement period most forest stands experienced at least several fires each century, suggesting a mixed fire regime of frequent low- to moderate-intensity fires (Skinner et al. 2006), with low-severity fire composing the largest portion of burned area, and high-severity fire the smallest portion (Agee 1993). Low-severity fire has been defined as those which kill less than 20% of the basal area; high-severity fire causes high tree mortality, with mortality of 70% and above used to define high-severity burns (Agee 1993, Hessburg et al. 2005). Under stable atmospheric conditions, current fires tend to follow a mixed fire regime similar to historical patterns (Taylor and Skinner 1998, Odion et al. 2004). Variation within the mixed-severity fires of the Klamath region has been strongly influenced by topography in both the presettlement and contemporary periods (Taylor and Skinner 1998). As described by Skinner et al. (2006),

“Generally, the upper third of slopes and the ridgetops, especially on south- and west-facing aspects, experience the highest proportion of high-severity burn...The lower third of slopes and north- and east-facing aspects experience mainly low-severity fires. Thus, more extensive stands of multi-aged conifers with higher densities of old trees are found in these lower slope positions. Middle slope positions are intermediate between lower and upper slopes in severity pattern.”

This topographically-controlled fire regime is the most widespread regime in the Klamath Mountains and is controlled by greater heating and drying on certain portions of mountain slopes and climatic variables in deep canyons (Skinner et al. 2006). Temperature inversions that often occur while fires are burning enhance this topographic pattern of fire intensity (Skinner et al. 2006). Historical fires were patchy and relatively small, although fires of up to several thousand acres were relatively common, and the majority of burned areas experienced low and moderate severity fire (Spies et al. 2006). The frequent occurrence of mixed-severity fires created a diverse landscape of older forest with variable openings of younger forest and nonforested areas, with the relative composition of these forest types varying depending on slope position.

Historical Fire Regime in the Cascades Province

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4329 South of the latitude of Mt. Shasta in the California Cascades, the vegetation composition and species
4330 dominance of lower and mid-montane forests is similar to that in the northern Sierra Nevada, and upper
4331 montane forests are more similar to the Klamath Mountains (Skinner and Taylor 2006). Conifer forests
4332 dominate the mid-montane zone on both sides of the Cascade Range and are intermixed with
4333 woodlands and shrublands. On the west side of the Cascades, mixed-species conifer forests dominate
4334 with any of six conifer species co-occurring or sharing dominance (Skinner and Taylor 2006). A
4335 subcanopy of mixed hardwoods may occur beneath the conifer canopy. Extensive areas on the east side
4336 of the Cascade Range are dominated by either ponderosa pine or Jeffrey pine (collectively referred to as
4337 yellow pine; Skinner and Taylor 2006). These forests are less complex than those on the west side with
4338 fewer co-occurring species of conifer and with relatively poor-developed understory historically.
4339 Accordingly, yellow pine-dominated forests had a distinct, more uniform fire regime.

4340 Forest species composition and structure in the different portions of the Cascades Province is related to
4341 fire regime, with areas of mixed-severity fire regimes that occur in the Klamath and portions of the
4342 Cascades frequently supporting multi-storied old growth and the drier forests further east (dominated
4343 by yellow pine) experiencing more frequent, low-severity burns and decreased diversity (Spies et al.
4344 2006). As in the Klamath Mountains, fire-severity in the California Cascades is associated with
4345 topographic position with the high-severity portion of burns more likely to occur on upper slopes and
4346 the low-severity burns occurring predominately on lower slopes. This pattern is less pronounced in the
4347 Cascades than in the more extreme terrain of the Klamath Mountains (Skinner and Taylor 2006). As in
4348 the Klamath region, in regions of the Cascades where fire regime is influenced by topography multi-aged
4349 and multi-sized forests are concentrated on the lower slopes and more even-aged stands that develop
4350 after high-severity burns mostly occurred on upper slopes (Skinner and Taylor 2006).

4351 The portion of the Northern Spotted Owl range which is dominated by ponderosa pine is relatively
4352 uncommon and is distributed in a narrow band on the east side of the Cascades and in limited areas in
4353 southwestern Oregon and northern California (Spies et al. 2006). Jeffrey-pine-dominated forests occupy
4354 the lower elevations on south-, east-, and west-facing slopes in eastside environments (Skinner and
4355 Taylor 2006). These forests occur in the driest portions of the northern spotted owl range. Ponderosa
4356 and Jeffrey pine dominated forests have a distinctly different structure and historical fire regime in
4357 comparison to the mixed conifer forests of the rest of the Klamath and Cascade provinces. Historically,
4358 frequent low-severity burns resulted in low and variable tree densities, with low, patchy developed
4359 understory, and reduced fuel loads (Hessburg et al. 2005). Frequent burns favored fire-tolerant tree
4360 species such as ponderosa pine and maintained fire-tolerant forests by elevating tree crowns and
4361 consuming many small and medium sized trees (Hessburg et al. 2005). The forest structure and
4362 composition in these yellow pine forests that resulted from frequent fires reinforced the occurrence of
4363 low-severity fires by limiting the conditions that could support high severity fires (Hessburg et al. 2005).
4364 Historical open yellow pine forests would not have provided all necessary habitat conditions for the
4365 Northern Spotted Owl, but local areas of high density and complex structure likely provided
4366 requirements for nesting and roosting (Davis et al. 2011) among a landscape of mixed forest types and
4367 nonforest areas.

4368 Recent Changes in Fire Regimes and Possible Causes

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4369
4370 Multiple potential causes have been implicated in increasing fire activity over the last several decades.
4371 The success of fire suppression and exclusion has indirectly advanced secondary succession in forests
4372 and changed forest composition by increasing tree density, decreasing prevalence of fire-tolerant tree
4373 species (e.g., ponderosa pine and Jeffrey pine), and contributing to homogenization of forest structure.
4374 In some cases, timber harvest has directly advanced secondary succession through the selective removal
4375 of the largest trees (Hessburg et al. 2005). Post-harvest tree plantations have created homogeneous
4376 forests dominated by even-aged, smaller-diameter trees that in some cases are less resistance to fire. In
4377 addition, climate variables, including temperature and precipitation, have produced conditions that
4378 promote increased amounts of fire activity.

4379 Beginning in the early 1900s in accessible areas and in the mid-1900s in remote areas, fire suppression
4380 caused a dramatic decline in fire occurrence in the Klamath province (Skinner et al. 2006). The result was
4381 a series of decades, beginning in the early 1900s, with dramatically reduced fire extent over most of the
4382 Klamath region (Taylor and Skinner 1998, 2003; see Figure 23 for example). During this period the fire
4383 rotation (time required to burn an area equal to a defined area of the landscape) increased to an
4384 estimated 974 years in the early 1980s (Miller et al. 2012) compared to a historical estimate for fire
4385 rotation of only 20 years (Taylor and Skinner 2003). In the Cascade Province the fire suppression period
4386 began in the early 1900s. The gentler slopes of the Cascade Province, relative to the Klamath region,
4387 lead to successful fire suppression efforts. This success resulted in a dramatic change in fire frequency
4388 from high frequency low-severity fires to a period of minimal fire occurrence in the California Cascades.

4389 Following several decades of reduced extent and frequency of fire as a result of fire suppression efforts,
4390 the average fire size has increased in recent decades (beginning in the 1980s) across the western United
4391 States (Schwind 2008, Westerling et al. 2006), including the area comprising the Northern Spotted Owl
4392 range in California (Odion et al. 2004, Miller et al. 2012). The area burned annually within the entire
4393 range of the Northern Spotted Owl (Davis et al. 2011) and within the California portion of the range
4394 (Miller et al. 2012) also increased dramatically during this time and the regional fire rotation fell to 95
4395 years by 2008 (from a high of 974 years in the early 1980s). As noted in Figure 24, the years between
4396 1970 and 2009 with the most area burned per year in the California portion of the Northern Spotted Owl
4397 range have all occurred since 1987 (Davis et al. 2011, Miller et al. 2012). Mixed-species forests on the
4398 west side of the California Cascades have changed with the success of fire suppression, with forest
4399 density increasing and species composition shifting toward fire-sensitive white fir (Norman and Taylor
4400 2002, Skinner and Taylor 2006). Although the Cascades portion of the Northern Spotted Owl range in
4401 California has not experienced the number or extent of uncharacteristically large fires that have
4402 occurred in the Klamath province, in recent years several large fires have burned in the eastern Cascades
4403 of Oregon and Washington and in the southern portion of the California Cascades. The gentler
4404 topography of the Cascades is more conducive to extensive fires than the Klamath region (Norman and
4405 Taylor 2003, Skinner and Taylor 2006); where forests have developed high densities of young trees due
4406 to fire suppression, fires that escape fire suppression efforts can become large and burn at high-severity
4407 (Skinner and Taylor 2006).

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4408 Although there is evidence that the increase in fire size in recent years has corresponded with an
4409 increase in fire severity in the western U.S., including the Sierra Nevada (Hessburg et al. 2005, Schwind
4410 2008, Miller et al. 2009), trends in burn severity have been less conclusive than trends in fire size and
4411 total area burned (Schwind 2008). There is evidence from both the Klamath and Cascade provinces of
4412 California that the proportion of fire-severities in recent mixed-severity fires has been consistent with
4413 historical patterns, or that change has only been evident in most recent years (Odion et al. 2004, Hanson
4414 et al. 2009, Miller et al. 2012).

4415 Some researchers have challenged the common perception that fire suppression and fuel build-up is the
4416 main cause of increased fire activity. In their study of large fires in the Klamath Mountains, Odion et al.
4417 (2004) evaluated fire history from 1977 to 2002 and concluded that fuel build-up in the absence of fire
4418 did not occur, and instead fuel that is receptive to combustion may decrease in the long absence of fire
4419 in the study area. These authors also evaluated patterns of burn severity in a nearly 100,000-ha fire that
4420 burned in the Klamath Mountains in 1987 to test the effect of fire history, past timber management, and
4421 vegetation structure on the extent and severity of current fire. Odion et al. (2004) found that multi-
4422 aged, closed forests generally burned at low severity, even where fire suppression efforts had limited
4423 fires over the previous decades. The same study found that areas with a history of high-severity fire and
4424 areas with large amounts of even-aged tree plantations experienced elevated amounts of high-severity
4425 fire. These findings are counter to the common assumption that increased extent of high density forests
4426 will lead to increased occurrence of high-severity fire. The additional findings suggests that the historical
4427 pattern of mixed-fire regime in the Klamath continues to drive patterns of at least some contemporary
4428 fires and can act to maintain diverse, heterogeneous forests (Odion et al. 2004).

4429 Miller et al. (2012) conducted a broad assessment of patterns in the extent of high-severity fire in four
4430 national forests of northwestern California. Their study covered all fires larger than 100 acres during the
4431 years 1910 to 2008 in a 5.8 million acre area including the northern California Coast Range and the
4432 Klamath Mountains, as well as a portion of the southern Cascade Range. This study area covers most of
4433 the range of the Northern Spotted Owl on federal land in California. Although the authors observed
4434 significant increases in both fire size and total annual area burned from 1910 to 2008, they found no
4435 temporal trend in the percentage of high-severity fire in recent years.

4436 Despite the findings of Odion et al. (2004) and Miller et al. (2012), at least one recent fire, the Biscuit
4437 Fire of 2002, has occurred in the Klamath province that was not only large but was of uncharacteristic
4438 high-severity (Skinner et al. 2006). The Biscuit Fire burned about 500,000 acres in southern Oregon and
4439 northern California. Almost 224,000 acres (49%) burned at high severity, with 75-100% canopy tree
4440 mortality, and an additional 14% of the burn area experienced 50-75% mortality (USFS 2003). This large,
4441 relatively high-severity burn was inconsistent with historical burn patterns and was associated with
4442 weather conditions that are conducive to fire (i.e., high winds and low humidity). Conversely, in the
4443 years when the most area has burned in the Klamath province of California since the 1980s, fires have
4444 primarily been caused by region-wide lightning events that strain fire suppression resources and that are
4445 associated with more moderate meteorological conditions. Overall fire severities were relatively low in
4446 these years due to the long duration of fires, weather conditions, and strong inversion events (Miller et
4447 al. 2012).

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4448 Steel et al. (2015) presented evidence that the response of fire regime to past fire suppression varies
4449 with forest type and the degree to which fire in an ecosystem is fuel-limited or climate-limited. Forests
4450 with fire regimes that are more fuel-limited (e.g., yellow pine forests and mixed conifer forests found in
4451 much of the interior portion of the Northern Spotted Owl range in California) should experience
4452 increases in fire severity following periods of fire suppression, whereas forests with fire regimes that
4453 have been historically climate-limited (e.g., redwood forests) would be less altered by a history of
4454 suppression. Using data on fire severity for 660 fires that occurred on USFS land in California between
4455 1984 and 2011, Steel et al. (2015) showed that the proportion of fires burning at high severity has
4456 increased for fuel-limited forest types. This increase in severity was correlated to indicators of fire
4457 suppression for much of California; however, the Klamath bioregion did not show this relationship. This
4458 suggests that fire severity, or at least the occurrence of high severity fire in the Klamath bioregion may
4459 be more limited by climate than by fuel loads. This may explain inconsistent observations of fire severity
4460 trends for the Klamath region, with measured proportions of high intensity fire varying on a case-by-
4461 case basis, depending on climatic conditions during the fire.

4462 Where increases in fire size or severity have been observed in recent years in forests of the western
4463 United States, it has often been attributed to increased densities of fuels and development of ladder
4464 fuels as a consequence of fire suppression. Fire suppression and exclusion in ponderosa pine forests has
4465 been successful at reducing the frequency of fire which allowed for the development of shade-tolerant
4466 trees and understory vegetation in the previously open forests, and resulted in an increase in stand
4467 density (Taylor 2000). Resource-stressed stands are more susceptible to insects and disease which
4468 results in an increase in weakened or dead trees and heavy fuel loadings (Hessburg et al. 2005, Davis et
4469 al. 2011). This has led to fuel characteristics in ponderosa pine forests that can support larger and more
4470 severe wildfires (Hessburg et al. 2005). Large, severe fires in the dry eastern Cascades of Oregon and
4471 Washington have occurred in recent years (Davis et al. 2011), and the potential remains for the loss of
4472 large amounts of nesting and roosting habitat.

4473 Past management practices that have established more homogeneous even-aged forests (e.g., fire
4474 suppression, livestock grazing, and timber harvest practices) may provide forest conditions that are
4475 conducive to high-severity fires in forests with fire regimes that were historically fuel-limited. Repeated
4476 selection cutting of the largest trees had the effect of advancing secondary succession, resulting in
4477 younger forests with higher density, fire-intolerant trees (Hessburg et al. 2005). Recent large, high-
4478 severity fires and timber harvest practices have expanded the amount of even-aged plantations,
4479 hardwood stands, and shrublands (Skinner et al. 2006). Prior to fire suppression, the forest landscape in
4480 the Klamath Mountains contained stands of even-aged forests, but they do not appear to have occupied
4481 extensive areas (Taylor and Skinner 1998, 2003, Skinner et al. 2006). Odion et al. (2004) reported that
4482 plantations occur in one-third of the roaded landscape in their large fire study area in 1987. Extensive
4483 areas of young even-aged forests that have resulted from a combination of past fire and past timber
4484 harvest practices may amplify conditions for repeated high-severity fires compared to heterogeneous
4485 forests that were created by historical patterns of mixed-severity fires (Spies et al. 2006). A positive
4486 feedback resulting from past timber management and fire suppression practices, existence of increased
4487 even-aged stands in the forest matrix, and future high-severity fire has the potential to support a new

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4488 forest matrix with stable or increasing amounts of even-aged forest and decreased heterogeneity
4489 (Skinner et al. 2006).

4490 Several studies have determined a strong link between changes in fire extent, severity and season, with
4491 low precipitation and high temperatures. In addition to land-use history over the last century, climate
4492 variables (e.g., precipitation, temperature) have been evaluated as potential causes of recent increases
4493 in large wildfires. There is an important distinction between these two potential causes. Changes in
4494 forests brought about by land-use history may be reversible through management actions, such as
4495 forest thinning and prescribed fire, while reversing trends in climate warming are unlikely in the near
4496 future (Westerling et al. 2006, Littell et al. 2009). Littell et al. (2009) found that in areas with low fuel
4497 loads the impacts could be lessened through fuel reduction prescriptions, however in areas that are
4498 experiencing low precipitation, this may prove less useful).

4499 Under various climate change scenarios (as discussed in the Climate Change section of this report), fire
4500 seasons have been predicted to be longer and fire sizes larger (McKenzie et al. 2004, Westerling and
4501 Bryant 2008, Littell et al. 2009, Miller et al. 2009, Westerling et al. 2011). For example, McKenzie et al.
4502 (2004) found that extreme fire weather (e.g., hot dry summers) in western America will influence the
4503 severity and the total area burned, with the duration of the fire season lengthened with more fires
4504 occurring early and later in the typical fire season. Westerling et al. (2006) found that periods with large
4505 fire occurrences corresponded with a shift toward warm springs and longer summer dry seasons, and
4506 suggested that both land use and climate have contributed to increased fire risk, but that broad-scale
4507 increases across the western U.S. were driven primarily by recent trends in climate.

4508 Compared to pre-European settlement, Miller et al. (2009) found that high severity fires in low- to mid-
4509 elevation forests are increasing of California and western Nevada. Miller et al. (2009) suggests that snow
4510 water deficits, earlier snowmelt, lengthening of the fire season, worsening drought conditions, low fuel
4511 moisture, and increase of forest fuel availability all play a role in how forests are in a position to burn
4512 more often and at higher severity. In this study, types of forested land most impacted by high severity
4513 fires include those on National Forest land, those experiencing high resource extraction and rapid
4514 human population growth, and those supporting old growth dependent species (Miller et al. 2009).

4515 Another study in the western United States supported theory that climate is a driving factor influencing
4516 fire extent in the 20th century, and fire regimes will vary dependent on fuel energy and water deficits
4517 (Littell et al. 2009). Low precipitation and high evapotranspiration in mountainous ecoprovinces of the
4518 western United States lead to low fuel moisture conditions; thus, creating a system at higher risk to
4519 combustion and fire spreading (Littell et al. 2009). Similar to Miller et al. (2009) findings, Littell et al.
4520 (2009) suggests low precipitation, warmer winters, reduced snowpack and drought effects lead to
4521 increases of forested area burned.

4522 With future climate change, the continued occurrence of large, uncharacteristically severe fires may
4523 become increasingly common. These changes may in turn impact the habitat, distribution and
4524 abundance of sensitive species such as the Northern Spotted Owl.

4525 Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat

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4526

4527 Variation in fire severity has an important influence on forest structural diversity because low-severity
4528 fires kill few trees while high-severity fires may kill all trees in a stand (Taylor and Skinner 2003). High-
4529 severity fires tend to result in even-aged stands while lower severity fires result in forests with multiple
4530 age classes. In much of California, the Northern Spotted Owl evolved in a landscape of frequent, mixed-
4531 severity fire, with most burns occurring at low severity and a relatively small amount of burns occurring
4532 at high severity. In the drier portion of the Northern Spotted Owl range, the species is likely adapted to
4533 the heterogeneous landscape resulting from regular, mixed-severity fire. Prior to fire suppression, the
4534 frequent occurrence of mixed-severity fires in large portions of the Klamath and Cascade ranges, along
4535 with the resulting complex landscape (e.g., older forests with openings of other forest types intermixed
4536 with nonforested areas) was prominent throughout the region. The historical mixed fire regime in the
4537 Klamath region may have benefited Northern Spotted Owl habitat by maintaining areas of older forests
4538 with dense canopies and complex structure, while also providing a heterogeneous landscape composed
4539 of multiple forest ages and structure. This pattern could have supported high quality habitat mosaics of
4540 nesting and roosting habitat and diverse foraging habitat which lead to high survival and reproductive
4541 success (Franklin et al. 2000).

4542 Current fire regime and its potential to impact Northern Spotted Owl habitat depends on a number of
4543 factors including: fire management history, logging history, forest type, historical fire regime, weather
4544 patterns and climate change. Additionally, observed impact to Northern Spotted Owl is likely
4545 complicated by occurrence of post-fire salvage logging. Although forest heterogeneity has decreased
4546 with recent management practices, the forests of the Klamath Mountains continue to provide habitat
4547 for Northern Spotted Owl. More information is needed on the effect of historical fire suppression and
4548 current fire regimes on owl habitat, especially on the quality of habitat as assessed through
4549 demographic rates at individual owl territories. Most fires in the Klamath region continue to burn under
4550 historical mixed regimes that can contribute to a heterogeneous forest landscape. However, recent
4551 large fires are cause for concern for the future stability of forest conditions in the region, especially
4552 considering the higher percentage experiencing high-severity burns. Large amounts of Northern Spotted
4553 Owl nesting and roosting habitat has been lost to wildfire since implementation of the NWFP, with the
4554 majority being lost in a few very large fires (e.g., the Biscuit Fire of 2002) (Davis et al. 2011). Fires have
4555 been more frequent during dry years (Cook et al. 1996) and extreme weather events influence the
4556 occurrence of large, landscape-scale fires (Miller and Urban 2000). Wildfire has been the leading cause
4557 of nesting and roosting habitat loss on federal lands in recent decades; if large fires continue to occur in
4558 the future, much more habitat may be lost.

4559 Historical fire suppression and exclusion in ponderosa pine forests in the Cascades was successful at
4560 reducing the frequency of fire which allowed for the development of shade-tolerant trees and
4561 understory vegetation in the previously open forests, and resulted in an increase in stand density (Taylor
4562 2000). This may have improved nesting and roosting habitat conditions for Northern Spotted Owls in
4563 these forests compared to the pre-suppression period. However, high densities of younger trees as a
4564 result of fire suppression and timber management practices have created conditions with potential for
4565 stand-replacement fires in ponderosa pine forests. Ideally a landscape-scale management strategy for

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these forests would retain large, dense patches of forests embedded in a matrix with reduced stand densities to limit the potential for stand-replacement fire and competitive pressure on old trees (Thomas et al. 2006).

With the complexity of fire regimes in the state, the sometimes equivocal effects on Northern Spotted Owls, the uncertain contribution of fuel build-up, and climate influences on future fire frequency and severity, there has been disagreement on the level of risk that fire poses in the dry portions of the Northern Spotted Owl range. Hanson et al. (2009) reported that the risk of fire to Northern Spotted Owl habitat in the dry provinces had been overestimated in the 2008 Recovery Plan, which included ongoing loss of habitat as a result of timber harvest and fire as threats to the Spotted Owl (USFWS 2008a). This claim of overestimation was made based on calculated rates of old-forest recruitment exceeding rates of high severity fire in old-forests (Hanson et al. 2009). Spies et al. (2010) criticized the findings of Hanson et al. (2009), stating that an incorrect threshold was used to estimate extent of high severity fire and that an incorrect depiction of error was used to support selection of the threshold. Spies et al. (2010) also disagreed with the methodology used by Hanson et al. (2009) to estimate the rate of recruitment of old forests.

This debate on the risk of fire to Northern Spotted Owl habitat has important management implications. If recent and projected changes in fire size or severity continue to remove large amounts of nesting and roosting habitat, fuel treatments (e.g., thinning and prescribed fire) to reduce fire risk may have long-term benefits to owls by encouraging the development and maintenance of older forest patches while limiting the risk of stand-replacing fires. However, if recent large high severity fires are an anomaly and recruitment of old forest outpaces losses to high severity fire, natural processes can be incorporated into management plans to shape Spotted Owl habitat on the dry province landscape. Hanson et al. (2010) recommended small-scale experiments to study owl response to fuel treatments rather than large-scale implementation. Risks are not likely to be uniform across the range, with ponderosa pine forests likely having a different response to past management than mixed-conifer forests of the Klamath, for example. The 2011 Revised Recovery Plan recommends formation of working groups to inform management in both the Klamath and dry Cascade provinces (USFWS 2011a).

Climate Change

According to global and regional climate scenarios, many species will be required to adapt to changes in temperature, precipitation, forest structure, etc., or face eminent declines or extirpation. The degree of threat varies based on species and region. Climate change scenarios have been modeled across the range of the Northern Spotted Owl, including in California. Several studies have been conducted to assess the threat to Northern Spotted Owl specifically.

Climate Change Projection Modeling

In California, a multitude of climate change studies have been conducted. As noted by Pierce et al. (2012), a common theme among the California-specific studies indicates temperature showing a consistent positive trend, but changes in precipitation vary. Generally, most studies agree that California

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4603 will retain its Mediterranean climate of cool/wet winters and hot/dry summers, yet the degree of
4604 wetness/dryness will be amplified (Lenihan et al. 2003, Cayan et al. 2012).

4605 The projected climate model simulations from Cayan et al. (2012) exhibit warming over California, with a
4606 mid-century rise of approximately 1°C to 3°C (1.8°F to 5.4°F), and 2°C to 5°C (3.6°F to 9°F) rise by end-of-
4607 twenty-first century. Pierce et al. (2012) showed an average yearly increase in temperature over
4608 California of 2.4°C by the 2060s, with coastal areas showing less warming (1.9°C) than interior areas
4609 (2.6°C). Westerling and Bryant (2008) predicted an average increase of 4.3°C in California by 2070–2099.
4610 Seasonally, the summer and fall months exhibit greater warming than winter and spring months (Cayan
4611 et al. 2012, Pierce et al. 2012), with the degree of warming increasing as one moves from the coast to
4612 the interior of the state (Cayan et al. 2012). Extreme temperature events (i.e., frequency of extreme hot
4613 days) will become more common place and may take place earlier in the season (Cayan et al. 2012).

4614 Climate projection modeling conducted by Cayan et al. (2012) show a high degree of variability between
4615 month-to-month and year-to-year precipitation with slight drying tendencies in some areas of California,
4616 which may suggest that California will remain at risk to drought and flooding events, with more
4617 prominent changes in the southern portion of the state than the northern portion. Seasonal changes in
4618 precipitation included a somewhat contracted wet season, with less precipitation during late winter and
4619 spring than during the core winter months (Cayan et al. 2012). Pierce et al. (2012) found precipitation
4620 decreased overall in the southern portion of California (<10%) by the 2060s, but remained unchanged
4621 from historical levels in the northern portion of the state. Seasonally, winters in the northern portion of
4622 the state were wetter and offset by drier conditions the rest of the year by the 2060s, while the
4623 southern part of the state showed moderate decreases in fall, winter, and spring but stronger increases
4624 in summer (Pierce et al. 2012).

4625 Dalton et al. (2013) summarizes climate projection models for the Coastal, Cascade and Rocky Mountain
4626 ranges of Washington, Oregon and Idaho (e.g., Northwest). This paper indicates that the region showed
4627 an overall increase of temperature year-round (warming of at least 0.5 °C (0.9 °F) in every season), but
4628 more prominent warming during summer months. Modeling showed mixed results for annual
4629 precipitation, indicating little change from present (models ranged from –4.7% to +13.5%). Seasonally,
4630 most models showed a decrease in precipitation during summer months and increased precipitation
4631 during the other seasons (the largest projected change of about –30%). Dalton et al. (2013) climate
4632 models are in agreement that heat extremes will increase and cold extremes will decrease. Along the
4633 Northwest coast, sea level rise was projected to rise 4 to 56 in (9–143 cm) by 2100, with significant local
4634 variations.

4635 *Climate Change Impacts to Forests*

4636 In the Northwest and in California, changes in precipitation and temperature may impact forest
4637 distribution, growth, and structure (Lenihan et al. 2003, Dalton et al. 2013, Vose et al. 2012, McIntyre et
4638 al. 2015). Most climate projection models indicate upward elevational shift and a northward latitudinal
4639 shift in forest habitats (Vose et al. 2012). In climate projection scenarios specific to California, Lenihan et
4640 al. (2003) noted the most notable response to increase temperature was a shift from conifer-dominated

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4641 forests to mixed conifer-hardwood forests in the northern half of the state (e.g., the replacement of
4642 Douglas fir-white fir forest by Douglas fir-tan oak forest in the northwest) and an expansion of conifer
4643 forests into the northeast portion of the state (e.g., Modoc Plateau) by the 21st century. McIntyre et al.
4644 (2015) found similar results when comparing historic forest survey data (1930s) with recent surveys
4645 (2000s) to elucidate forest structure and composition shifts over time within the entire latitudinal extent
4646 of forests in California. This study found that today's forests are exhibiting an increase dominance of
4647 oaks (*Quercus*) at the expense of pines (*Pinus*). McIntyre et al. (2015) also found that across the
4648 120,000km² study area, large trees declined by 50% with a 19% decline in average basal area and
4649 associated biomass since the early 1900s. Understanding the shifts in structure and species composition
4650 is complex, but McIntyre et al. (2015) partially attributed these shifts to water deficits within California
4651 forests (e.g., drought), while acknowledging other contributing factors such as logging and fire
4652 suppression (McIntyre et al. 2015). Conifer-dominated forests (e.g., redwood and closed-cone pine
4653 forests) along the north-central coast of California (e.g., Crescent City south to Monterey) were
4654 projected to advance, resulting in redwood forests shifting inland into Douglas-fir-tan oak forests
4655 (Lenihan et al. 2003). Dalton et al. (2012) found that Douglas-fir forests in the Northwest may
4656 experience substantial declines through the 21st century. Tree productivity along California's north-
4657 central coastal and at high elevation forests was shown to increase in response to increased growing
4658 season temperatures; however, increases in productivity along the coast would only be seen if there
4659 was a persistence of coastal summer fog (Lenihan et al. 2003). Lenihan et al. (2003) suggests that if
4660 summer fog were to decrease in concert with increased temperatures, productivity of redwood forests
4661 along the coast would suffer reductions, or worse, would be eliminated entirely.

4662 Vulnerability to disturbance, such as wildfire, disease and insect outbreaks, is expected to increase in
4663 most forests in the Northwest and may change forest composition and structure depending on changes
4664 to climate (Dalton et al. 2012, Vose et al. 2012). According to Davis et al. (2011), one of the objectives of
4665 US Forest Service is to develop projections for wildfire regimes and habitat shifts due to changing
4666 climate and increased threats from wildfire, disease and insect outbreaks. Vose et al. (2012) effectively
4667 summarizes the nationwide effects of climate driven disturbance as follows:

- 4668 • Wildfire will increase causing a doubling of area burned by mid-21st century
- 4669 • Insect infestations (e.g., bark beetle in the western US) will expand
- 4670 • Invasive species will likely become more widespread, and especially in areas with increased
4671 disturbance and in dry forests
- 4672 • Increased flooding, erosion and sediment transport caused by increase precipitation, area of
4673 large burned areas, and rain-snow ratios
- 4674 • Increases in drought occurrences, exacerbating other disturbances (e.g., fire, insect outbreaks,
4675 invasive species), which will lead to higher tree mortality, decreased regeneration in some tree
4676 species, and alteration of tree species composition and structure

4677 Climate modeling studies agree that forest wildfire occurrence and severity will increase due to warmer
4678 spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and
4679 longer drier summers (Swetnam 1993, National Assessment Synthesis Team 2000, Houghten et al. 2001,

Comment [LVD113]: 117. I am not sure where it has been published (I have only seen the data in presentations and local media), but Steve Sillett's research on redwoods has shown the exact opposite. He has recorded unprecedented rapid growth in recent years with less fog and higher summer temperatures.

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4680 Lenihan et al. 2003, Westerling et al. 2006, Westerling and Bryant 2008, McKenzie and Littell 2011, Vose
4681 et al. 2012). Spracklen et al. (2009) projected that forests of the Pacific Northwest forests will experience
4682 increases in mean annual area burned, with a projected increase of 175% by 2050 compared to areas
4683 burned between 1996 and 2005. This increase will likely negatively impact old-growth forests and the
4684 species that inhabit them (Dalton et al. 2012, Vose et al. 2012). By evaluating fire history and climatic
4685 data in forested areas across the western United States over a 34-year period, Westerling et al. (2006)
4686 tested the contributions of land use and climate conditions on occurrence of large fires. Over this study
4687 period, the frequency and size of wildfires showed a marked increase in the mid-1980s; a large portion
4688 of this increase occurred in the range of the Spotted Owl in California (Sierra Nevada, southern
4689 Cascades, and Coast Ranges of northern California). The period of increase in large fire occurrence
4690 corresponded with a shift toward warm springs and longer summer dry seasons (Westerling et al. 2006).
4691 The authors concluded that both land use and climate have contributed to increased fire risk, but that
4692 broad-scale increases across the western U.S. were driven primarily by recent trends in climate. For
4693 California as a whole, by the end of the 21st century, risk of large fire will increase between 12 and 53
4694 percent compared to observed fire regimes between 1980 and 1999, and for northern and southern
4695 California, large fires will increase 15 to 90 percent and -29 to 28 percent, respectively (Westerling and
4696 Bryant 2008). See the Wildfire section above for more detailed discussion on wildfire impacts to forest
4697 systems.

4698 *Climate Change Impacts to Northern Spotted Owl*

4699

4700 Northern Spotted Owls utilize older structurally complex forests, in part, to facilitate thermoregulation
4701 and to provide protection from predators. Forest type and age within owl habitat varies by region.
4702 Coastal regions are wetter and cooler with low elevation forests predominately composes of and tend to
4703 be redwoods species dominant and of a younger age class, whereas inland regions are drier and warmer
4704 and tend to be mixed conifer/hardwood or Douglas-fir dominant.

4705 Most climate projection scenarios agree that the forests in the Northern Spotted Owl's range will have
4706 wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased
4707 frequency and intensity of disturbance events. According to many climate projections, the frequency
4708 and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will
4709 increase over time. Extreme climatic variation has been linked to sudden large-scale mortality in avian
4710 populations in the past (Tompa 1971, Johnson et al. 1991, and Smith et al. 1991 as cited in Franklin et al.
4711 2000), and the literature studying Spotted Owl response to climate supports this.

4712 Studies have indicated that Northern Spotted Owl demographic rates are survival is thought linked to
4713 precipitation-weather patterns. Olson et al. (2004) stated that survival was negatively associated with
4714 early-nesting season precipitation, and positively associated with late-nesting season precipitation.
4715 Population growth for Northern Spotted Owls range-wide (Washington, Oregon and California) was
4716 positively associated with wetter conditions during the growing season (May through October) due to
4717 more favorable conditions for prey species, but negatively associated with cold/wet winters and nesting
4718 seasons, and during hot summers on four of the six study areas (Glenn et al. 2010). Over the extent of

Comment [LVD114]: 118.I don't understand this statement. Old growth redwood forests are some of the oldest forests in the state. Is this statement indicating there is less old growth on the coast relative to inland areas?

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late-successional reserve land covered by the NWFP, Carroll (2010) predicted that winter precipitation was closely associated with a decrease in Northern Spotted Owl survival and recruitment (i.e., the entirety of the Northern Spotted Owl range in Oregon, Washington and California). Using vegetation and climate variables, model results in Carroll (2010) predicted an initial northward expansion of high quality owl habitat, followed by a contraction as climate variables intensify over time.

In the Coastal and Klamath Mountains of northwestern California, Franklin et al. (2000) thoroughly examined the effects of climate on temporal and spatial variation of Northern Spotted Owl survival, reproductive output, and recruitment. In these models, climate explained most of the temporal variation in life history traits. The study suggested that the period most impacted by climate was during the spring, presumed largely due to higher energetic demands during the breeding season, as well as prey abundance and availability. In a study area immediately to the west in the coastal redwood region, Diller et al. (2010) also reported that early nesting temperature and precipitation impacted both survival and fecundity. Franklin et al. (2000) states, “extreme climate conditions during the early nesting period may exacerbate an energetic stress on an individual by decreasing it’s time to starvation.” However, the winter period did explain variation in recruitment, thought to be a function of reduced survival of young during their first year.

In Oregon and Washington, Glenn et al. (2011) found a negative association between Northern Spotted Owl reproduction (number of young fledged) and cold wet nesting season, thought to be a function or loss of eggs or young to exposure or terminating incubation (Forsman et al. 1984). Whereas, reproduction was positively associated with late nesting season precipitation and negatively associated with warm temperatures, thought to be a function of reduced prey abundance and availability. Interestingly Glenn et al. (2011) also found that number of young fledged per year declined when precipitation in the year prior deviated from normal, and that number of young fledged per year increased following warm wet dispersal seasons. Some of these results differ from California studies such as Franklin et al. (2000), and may be a function of differing habitat, climate and targeted prey species. Regardless, the study suggests that Northern Spotted Owl reproductive success involves a complex relationship between prey populations, body condition and climate-weather prior to and within the nesting season; a statement that, given the current literature on the species, certainly holds true for the species in California.

The literature also indicates that Spotted Owls are sensitive to heat stress (Franklin et al. 2000, Weathers et al. 2001), which may be more problematic as temperatures rise over time. For the California Spotted Owl, Weathers et al. (2001) found that when temperatures reached between 30 and 34°C, a relatively moderate level, owls increased behavioral heat responses (e.g., increase respiratory rate, gaping, wing drooping).

As previously discussed, structural complexity (broken top trees, snags, overhead cover) is an important habitat component for Northern Spotted Owls. Structural complexity is an important factor in determining the availability of suitable nest sites. Rockweit et al. (2012) found that nest type selection played a role in Northern Spotted Owl reproductive success in California during period of inclement weather (i.e., low temperatures and high winds). Nests that were more exposed to the elements, such

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4758 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at
4759 protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must
4760 include structurally complexity to provide nesting options with proper protection. The intensity of
4761 disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or
4762 detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced
4763 when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may
4764 increase the level of structural complexity.

4765 Habitat loss and alteration due to heightened disturbance events (e.g., wildfire, disease, insect
4766 outbreaks), may also impact forest species, such as the Northern Spotted Owl, by intensifying
4767 competitive pressure from other species, such as Barred Owl (Lenihan et al. 2003, Carroll 2010).

4768 Direct mortality of Spotted Owls from wildfire will likely increase as frequency and intensity of wildfires
4769 increases. Indirect impacts may also include an increased level of predation if there is loss of older or
4770 structurally complex forests. However, neither direct mortality nor increased predation is specifically
4771 addressed in the literature.

4772 To better understand potential climatic impacts to Northern Spotted Owls, the Department compiled
4773 average 30-year (1980-2010) and 5-year (2010-2014) precipitation and temperature data and calculated
4774 the percent change within the owls range. Decreases in precipitation were most apparent in the
4775 southern portion of the coastal range (Marin, Sonoma and Mendocino counties), and within the interior
4776 range (Figure 25). Increases of precipitation were more limited, with increases seen in a small portion of
4777 northern Trinity County, and scattered within Humboldt and Del Norte counties. This analysis generally
4778 shows a drying trend throughout the owl's range, except in the northern portion of the coastal province
4779 and some small portion of the Klamath province.

4780 Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-
4781 August) and winter months (December-February) separately. Comparing the 30-year average with the 5-
4782 year average, temperature increases during the summer months were seen mostly within the north and
4783 northwest portions of Siskiyou County (northern portion of the Klamath and Cascade provinces), and
4784 along scattered portions of the coastal province (Figure 26). As shown in Figure 26, temperature
4785 decreases in the summer months were seen most prominently within the rest of the interior (Klamath
4786 and Cascade provinces). During the winter months, temperature increases were seen within interior
4787 (Klamath and Cascade provinces), while decreases were seen most prominently in the coastal province
4788 (Figure 27). This analysis generally shows warmer winters and cooler summers compared to normal
4789 within the interior portion of the Northern Spotted Owl range, and cooler winters and warmer summers
4790 along the coastal portion of the range.

4791 It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many
4792 climate projections forecasting steady changes in the future. Climate change studies predict future
4793 conditions that may negatively impact owls, such as wet and cold springs, more frequent and sever
4794 summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased
4795 frequency of severe wildfire events. Yet in some instances predicted future conditions, such as increased

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4796 frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to
4797 the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change
4798 predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other
4799 areas of the range. Looking at past precipitation and temperature trends, drying trends across most of
4800 the owl's range in California coupled with warmer winters and cooler summers in the interior and cooler
4801 winters and warmer summers along the coast may play a role in both owl and prey population
4802 dynamics. It will require more time and research is needed to assess the extent of these climate
4803 impacts on survival, population growth and reproductive rates of Northern Spotted Owls in California,
4804 and to determine if negative impacts of climate change outweigh the positive ones.

Comment [LVD115]: 119. Current climate research is generally all about modeling what is going to happen in the future, which of course, is a "guessing game" at best. More models don't necessarily provide any additional certainty – only time will ultimately tell.

4805
4806 **Barred Owl**

4807 *Barred Owl Expansion and Current Status in California*

4808 Section needs to start with a brief description of the barred owl relative to spotted owls. Historically,
4809 Barred Owls were residents of the eastern United States and southern Canada, east of the Great Plains
4810 and south of the boreal forest, and also in disjunct regions of south-central Mexico (Mazur and James
4811 2000). Based on genetic analysis, Barrowclough et al (2011) found the disjunct Mexican
4812 populations to be distinct from populations in the United States and Canada at the species level, and
4813 recommended they be recognized as *Strix sartorii*. Barred Owls continue to occupy their historical range,
4814 and during the past century have expanded their range to western North America.

Comment [LVD116]: 120. I think you should add a description of the barred owl particularly in terms of how to tell them apart, their vocalizations and etc. It is also critical to point out the size differences since that is ultimately what gives the barred owls a competitive advantage over spotted owls in a territorial dispute.

4815 The timing and route of the Barred Owl range expansion into western North America has been debated
4816 by the scientific community and is not resolved. An early and long-held view has been that Barred Owls
4817 expanded their range to the west via the boreal forests of Canada (Grant 1966, Hamer 1988, Houston
4818 and McGowan 1999, Holt et al. 2001). Livezey (2009a) suggested a slightly different pattern of expansion
4819 based on records for more than 12,500 Barred Owl detections from 1873 to 2008. He suggested that the
4820 expansion began via riparian forests of the Missouri, Yellowstone, and Musselshell rivers of the northern
4821 Great Plains to the forested mountains of western Montana at the end of the 19th century (Figure 28).
4822 From Montana, he suggests that Barred Owls then expanded their range in multiple directions, including
4823 to the north and then east, where they encountered Barred Owls that were expanding their range west
4824 through the boreal forests of Canada. Whether the initial range expansion was via the boreal forest of
4825 Canada or the riparian corridors of the northern Great Plains, once Barred Owls reached British
4826 Columbia in the 1940s, they continued their range expansion to the north and west across Canada to
4827 southeastern Alaska, and south through Washington, Oregon, and California (USFWS 2011a, USFWS
4828 2013). The range of the Barred Owl now completely overlaps the range of the Northern Spotted Owl
4829 from southwest British Columbia south along the western portion of Washington, Oregon, and northern
4830 California, and also includes a significant portion of the range of the California Spotted Owl.

4831 Barred Owls were first detected in California in 1976 (Dark et al. 1998, B. Marcot in Livezey 2009a). From
4832 then until 1996, 61 Barred Owl sites were identified in California (Dark et al. 1998). The majority of these
4833 sites (73%) were occupied by single owls. The first report of breeding in California was in 1991 (T.

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4834 Hacking in Dark et al. 1998) and the first sighting in the Sierra Nevada was in 1991. The rate of
4835 detections of Barred Owls in California accelerated during the mid-1990s (Dark et al. 1998) and by 1996
4836 Barred Owls had been detected as far south as Sonoma County in western California and Yuba County in
4837 the Sierra Nevada. Forsman et al. (2011, Appendix B) presented data showing that the rate of detection
4838 continued to accelerate through the 2000s. Currently, the known range of the Barred Owl in California
4839 extends along the coast south to Marin County (Jennings et al. 2011, Ellis et al. 2013) and to Tulare
4840 County in the Sierra Nevada.

4841 The Department has processed data for 1,970³ Barred Owl occurrences in California (Figure 29), and 111
4842 additional occurrences of Barred-Spotted Owl hybrids. Occurrences include all detections of barred
4843 owls, whether or not they were associated with a nest or territory.

4844 Following the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two
4845 species have occasionally been observed. The majority of hybrid pairs observed in the field or
4846 genetically sampled resulted from a cross between a female Barred Owl and a male Spotted Owl (Haig et
4847 al. 2004, Kelly and Forsman 2004). Generally second generation hybrids are difficult to distinguish from
4848 barred or Spotted Owls using field identification only and genetic samples may be the only sure way of
4849 identification (Kelly and Forsman 2004). Both first and second generation hybrids were found to be
4850 reproductively viable to some extent (Kelly and Forsman 2004). Haig et al. (2004) found that the two
4851 species DNA sequences showed a large divergence and could be separated into distinct clades with no
4852 signs of previous introgression.

4853 *Potential Mechanisms of Barred Owl Range Expansion*

4854 Factors that may have facilitated the range expansion have been debated in the literature at length. As
4855 mentioned above, two possible routes for the initial expansion from eastern North America have been
4856 suggested (i.e., riparian forests of the northern Great Plains and the boreal forest of Canada). It has been
4857 speculated that an ecological barrier existed prior to the end of the 19th century and that changes, either
4858 anthropogenic or natural, removed the barrier, and allowed for the initial westward expansion of the
4859 Barred Owl range.

4860 The most prominent theory is that an increase in the number of trees and forested areas supported the
4861 expansion by providing suitable Barred Owl habitat where before there was none (e.g., within the Great
4862 Plains). The relatively fast Barred Owl range expansion coincides with a period of dramatic increases in

³ The 1,970 occurrences processed to date represent a subset of available data and come from 2 general sources: 1) state and private researchers, biologists and foresters from 1978-2013 and 2) the Forest Service's NRIS database with records from 1992-2011. Data omitted due to time constraints includes 1) hard copy data, 2) 2012-2013 NRIS detections and 3) NRIS detections that were within 1 mile of processed data to avoid duplicates; this data, not including duplicates, will be added in the future. An updated version of NRIS containing 2012 and 2013 detections is still needed. Additional data from the 2013 field season is also yet to be submitted. There is likely more data in holding and data from additional sources that has not been submitted.

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4863 wooded habitat across the northern Great Plains and the boreal forests of Canada following arrival of
4864 European settlers. Explanations for an increase in the number of trees are anthropogenic and include
4865 fire suppression, tree planting (including shelterbelts), extirpation of bison, and to a lesser extent
4866 reductions in beaver, elk and deer populations on the northern Great Plains due to market hunting (Dark
4867 et al. 1998, Wright and Hayward 1998, R. Gutiérrez in Levy 2004, Livezey 2009b). Livezey (2009b)
4868 evaluated the plausibility of barriers to range expansion that have been proposed. He provided strong
4869 evidence that the northern Great Plains were largely treeless prior to the range expansion, a finding that
4870 supported a lack of habitat as a potential barrier. He also evaluated a number of anthropogenic changes
4871 (as noted above) preceding or coincident with the expansion and that are likely to have greatly
4872 increased the forest habitat in the region. Livezey concluded that the most plausible explanation for an
4873 ecological barrier that existed prior to range expansion, the removal of which coincided with range
4874 expansion, is an increase in forest habitat, first along the rivers and later in the boreal forest. Tree
4875 planting and fires suppression are obvious causes of the increase in wooded area, and the timing of
4876 these precedes the expansion of Barred Owl to the west. Huge numbers of bison destroyed small
4877 wooded areas on the Great Plains through rubbing on older trees and browsing or trampling of young
4878 trees (Livezey 2009b). The extirpation of bison precedes the increase in wooded habitat on the northern
4879 Great Plains. Elk, deer, and beaver have also been shown to have local effects on forest habitat, and may
4880 have contributed to suppression of forests in the Great Plains, especially in the limited wooded habitat
4881 along riparian corridors (Livezey 2009b).

4882 Another theory is that increases in temperature may have improved habitat value for Barred Owls in the
4883 boreal forest (Johnson 1994, Wright and Hayward 1998, Monahan and Hijmans 2007). This theory is
4884 based on an assumption that the boreal forests of southern Canada were too cold to be tolerated by
4885 Barred Owls, and that a warming climate brought these forests into the range of temperature tolerance
4886 for the species, thereby eliminating a natural barrier to Barred Owl range expansion. Because portions
4887 of the current range of Barred Owls (e.g., northern Alberta and British Columbia, the Northwest
4888 Territories) are much colder than the forests of southern Canada, Livezey (2009b) rejected the
4889 hypothesis that a thermal barrier was preventing range expansion, but he suggests conducting
4890 additional research on the thermal tolerances of Barred Owls. Additionally, the temperature increase
4891 referenced in the literature occurred in part after the Barred Owl range expansion had begun (Johnson
4892 1994, Monahan and Hijmans 2007), calling this mechanism of range expansion into question.

4893 Once Barred Owls expanded across the middle of the continent, they encountered forests of the Rocky
4894 Mountains and the Pacific Northwest. Timber harvests may have facilitated the further expansion of the
4895 range by creating a mosaic of more open forest habitat that might be favored by a habitat generalist like
4896 the Barred Owl (Hamer et al. 1989, Dark et al. 1998). However, Barred Owls have become established in
4897 a variety of habitats, including mature forests that have not been harvested, challenging this as a factor
4898 in the further expansion of the range (USFWS 2013). In a coastal Oregon study, Wiens et al. (2014)
4899 showed that Barred Owls showed strong selection of old forests for both daytime roosting and
4900 nighttime foraging. Furthermore, the pattern of Barred Owl colonization in coastal northern California
4901 indicated that Barred Owls completely occupied the old growth forests of Redwood National and State
4902 Parks (see Occupancy section above, Schmidt 2013) while occurring in relatively low numbers on the

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4903 | adjacent managed timberlands of the Green Diamond study area (Diller et al. 2014, GDRCO 2015)
4904 | Because Barred Owls are habitat and prey generalists (as explained below), the suggestion that they
4905 | adapted to use of a novel (coniferous forest) habitat, which then allowed them to spread through the
4906 | boreal forest and the forests of the west has largely been dismissed (Livezey 2009b, USFWS 2013).

4907 *Spotted Owl and Barred Owl Habitat, Prey Selection, and Home Range*

4908 | Barred Owls tend to select low to high elevation areas with gentle slopes, large overstory tree with
4909 | expansive crown diameter, and evergreen stands with a dense canopy, but will also nest in areas with
4910 | young trees, deciduous tree species and open areas (Herter and Hicks 2000, Buchanan et al. 2004,
4911 | Gremel 2005, Hamer et al. 2007, Jennings et al. 2011, Mazur and James 2000, Pearson and Livezey 2003,
4912 | Singleton et al. 2010). Recently, Wiens et al. (2014) determined that Barred Owls used available forest
4913 | types more evenly than spotted owls selected a broad range of forest types in western Oregon, but were
4914 | more strongly associated with large hardwood and conifer trees within relatively flat areas along
4915 | streams. In the eastern Cascades Range in Washington, Singleton (2015) found Barred Owls used
4916 | structurally diverse mixed grand fir and Douglas-fir forests during the breeding season more often than
4917 | open ponderosa pine or simple-structure Douglas-fir forests, with less selection among forest types
4918 | during the non-breeding season. Spotted Owls may have a stronger affinity than Barred Owls to
4919 | Douglas-fir dominant forests and more abundant dwarf mistletoe infestations, an important habitat
4920 | feature for nesting Spotted Owls in the Washington's eastern Cascades (Singleton 2015). Similarities
4921 | between Barred Owl and Spotted Owl habitat preferences include selection of old forests with closed
4922 | canopy and a high degree of structural complexity for nesting and roosting activities (Mazur et al. 2000,
4923 | Singleton et al. 2010, Wiens et al. 2014, Singleton 2015). As Wiens et al (2014) points out, the similar
4924 | habitat preference for older forests highlights the importance for maintaining this forest type on the
4925 | landscape because a decrease in older forests will likely increase competitive pressure between the two
4926 | species. Differences of habitat selection include the tendency for selection of lower elevation sites with
4927 | gentle slopes (e.g., valley floors) by Barred Owls, the use of a larger variety of forest types by Barred
4928 | Owls, the stronger dependence on Douglas-fir dominant forests by Spotted Owls, and more abundant
4929 | mistletoe infestations by Spotted Owls. Currently, there is no indication that the two species can coexist,
4930 | sharing the same habitat and prey-base, because there is little evidence that nesting habitat or prey-
4931 | base can be adequately partitioned to prevent competition (Gutiérrez et al. 2007, Dugger et al. 2011,
4932 | Singleton 2015).

4933 |
4934 | Home range analyses show the importance of mature forests for nesting by both Barred and Spotted
4935 | Owls; however, one study in Washington indicated that Barred Owls select other forest cover types
4936 | similar to their availability whereas Spotted Owls are were more tightly associated with old forests
4937 | (Hamer et al. 2007, Singleton et al. 2010). Home ranges for both species have been found to be smaller
4938 | in old mature forests; however, within forest types, home ranges of Spotted Owls are 3 to 4 times larger
4939 | than those of Barred Owls (Hamer et al. 2007, Singleton et al. 2010, Wiens et al. 2014). In a western
4940 | Oregon study, Barred Owl home range and core area use (i.e., the portion of the fixed-kernel breeding
4941 | season home range in which use exceeded that expected under a null model of a uniform distribution of
4942 | space-use) was 581 ha and 188 ha, respectively; whereas Northern Spotted Owl home range and core
4943 | area use was much larger - 1843 ha and 305 ha, respectively (Wiens et al. 2014). In some-one areas of
4944 | sympatry, little overlap existed between Barred and Spotted Owl home ranges, which was indicative of
4945 | competitive exclusion of Spotted Owls by Barred Owls (Hamer et al. 2007, Singleton et al. 2010).
4946 | However, Wiens et al. (2014) found overlap between the two species with adjacent territories in
4947 | western Oregon to be 81%, with most space sharing in the foraging areas outside of the core area use.

Comment [LVD117]: 121. Diller, L. V., J. P. Dumbacher, R. P. Bosch, R. R. Bown, and R. J. Gutiérrez. 2014. Removing Barred Owls From Local Areas: Techniques and Feasibility. Wildlife Society Bulletin 3:211–216.

Comment [LVD118]: 122. “Used” versus “selected” may seem like a trivial difference but it actually does make a big difference. Wiens found no evidence that the 2 species differed in their use of young, mature, and riparian-hardwood forest types. If you look at Figure 7, Wiens et al. 2014 shows evidence for habitat selection for old-growth and hardwood forests during nighttime foraging and daytime roosting by barred owls and avoidance of non- and young forests and selection. They also showed avoidance of close proximity of high contrast edge

Comment [LVD119]: 123. This paragraph is about describing barred owl habitat so this statement about management implications of habitat selection seems out of place. It would make more sense to move it to the section below about the impacts of barred on spotted owls.

Comment [LVD120]: 124. In my opinion, the inferences that can be drawn from these two studies are relatively weak in comparison to Wiens et al. 2014. The Hamer study had a small sample size of spotted owls and in general they got relatively few telemetry locations and had to combine day and nighttime locations. The Singleton study only included telemetry data on barred owls, and he only had data on 14 birds, so he couldn't make any direct inferences about relative habitat use by the two species. His comparisons to spotted owls was based on published data, which provides no real data. In addition to having the largest number of both barred and spotted owls with a tremendous amount of telemetry data, the Wiens study was much closer to CA and therefore the two species were likely more ecologically similar than owls in WA.

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Despite overlap in foraging areas, Wiens et al. (2014) showed evidence that interference competition with barred owls for territorial space constrained the availability of critical resources required for successful recruitment and reproduction of spotted owls. Availability of old forests and associated prey species appeared to be the most strongly limiting factors in the competitive relationship between these species.

Barred Owls are opportunistic hunters that consume a wide array of prey, including small mammals ranging from rabbits to bats, small to medium sized birds, amphibians, reptiles, fish, and invertebrates; however, mammals make up a majority of prey items (Hamer et al. 2001, Mazur and James 2000), making them more of a generalist than Spotted Owls in their selection of prey. Hamer et al. (2007) measured a diet overlap by biomass of 76% between Spotted and Barred Owls in a region of sympatry in the Cascades of Washington. The most relevant study to California, Wiens et al. (2014) found dietary overlap by biomass between the two species to be moderate (41%) with Northern flying squirrel, woodrat and lagomorph species the primary prey for both (84% of Northern Spotted Owl diet and 49% of Barred Owl diet). Both studies suggest competition for food resources between the two species.

Prey species composition and density drive habitat selection and home range size for both owl species; however, Spotted Owls are more sensitive to fluctuations in prey abundance and availability than Barred Owls due to their more limited number of preferred prey species (Bond et al. 2013, Franklin et al. 2000, Hamer et al. 2007, Meyer et al. 1998, Thomas et al. 1990, Ward 1990, Zabel et al. 1995, Zabel et al. 2003, Wiens et al. 2014). The narrow range of prey selected by Spotted Owls contributes to the need for much larger home ranges in comparison to Barred Owls.

Impacts of Barred Owls on Spotted Owls

The expansion of the Barred Owl range into that of the Spotted Owl has been documented mainly through incidental detections during Spotted Owl surveys. Based on these detections, numerous researchers have reported that Barred Owl numbers quickly increase after a period of slow increase once they arrive in a new area (USFWS 2013). In the Oregon Cascades, Barred Owl detections increased from one initial detection in 1979 to over 700 detections by 1998 (Kelly 2001). Barred Owls can also quickly outnumber Spotted Owls; in the Northern Cascades in Washington, Barred Owl abundance was twice that of Spotted Owls within 17 years of the first detection (Hamer et al. 1988). In the range of the Spotted Owl, the density of Barred Owls is greatest in the north, where they have been present the longest (British Columbia and Washington), and fewer detections have been made in the southern edge of the range (California) where they have been present for a shorter duration (USFWS 2013). Despite this general north-south gradient in the density of Barred Owls, Dugger et al. (In press) provide strong evidence of increasing Barred Owl populations throughout the range of the Northern Spotted Owl and California Spotted Owl.

One of the first and most consistently documented impacts of Barred Owls on spotted owls was a reduction in detection and occupancy rates. A negative effect of barred owls on detectability of spotted owls was reported by several studies (Dugger et al. 2009, Olson et al. 2005, Crozier et al. 2006, and Wiens et al. 2010). Kelly et al. (2003) found that spotted owl occupancy was significantly lower in

Comment [LVD121]: 125. Moved forward from below. Providing this background on the expansion of barred owls seems like the most appropriate leadoff to the section.

Comment [LVD122]: 126. In many study areas, it has been 10-20 years from the initial colonization before barred owl numbers took off.

Comment [LVD123]: 127. I think it makes more sense to follow in chronological order and end with the latest and most important conclusions relative to barred owl impacts.

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4987 territories where barred owls were detected within 0.8 km of the territory center. Pearson and Livezey
4988 (2003), Gremel (2005) and Sovern et al. (2014) also reported relationships between barred owl presence
4989 and reduced site occupancy by spotted owls. In Olympic National Park, an area with historical Northern
4990 Spotted Owl territories, occupancy of Spotted Owls declined by almost 20 percent as Barred Owl
4991 presence increased by 15 percent between 1992 and 2003 (Gremel 2005). It has also been determined
4992 that Spotted Owls will move activities away from areas with Barred Owl presence even if they do not
4993 move their territory (Kelly 2001, Gremel 2005). Within the Hoopa Valley Indian Reservation (Humboldt
4994 County, California), Barred Owls were detected in over 85% of all historic Northern Spotted Owl
4995 territories between 2009 and 2014 (Higley and Mendia 2013). Northern Spotted Owl occupancy in the
4996 Hoopa study area started a steep decline in 2004, in concert with a boom in Barred Owl occupancy; and
4997 in 2013, Northern Spotted Owl occupancy was down to 0.595 while Barred Owl occupancy increased to
4998 0.838 (95% CI) (Higley and Mendia 2013).

4999 Spotted Owls will reduce their calls or not call at all if Barred Owls are in the vicinity (Cozier et al. 2006,
5000 Sovern et al. 2014), making it more difficult to detect Spotted Owls if Barred Owls are present. Thus,
5001 standard surveys might result in occupancy status being misclassified (e.g., a false-negative survey --
5002 designating sites as unoccupied by Spotted Owls when in reality Spotted Owls are present but are not
5003 vocalizing). Beyond land management implications (e.g., timber harvest or not), this behavior shift by
5004 the Spotted Owl may also have implications for reproduction because calls are used to defend a territory
5005 and locate mates, and during pair bonding and prey delivery to the nest site (USFWS 2013).

5006 Data ~~is~~ are lacking to adequately assess Barred Owl abundance in western North America. However,
5007 based on the most recent meta-analysis, Northern Spotted Owl populations are declining throughout
5008 most of their range (Dugger et al. In press). ~~The USFWS holds periodic workshops with Northern Spotted~~
5009 ~~Owl researchers to assess population parameters, such as abundance, trend and survival (USFWS 2013).~~
5010 ~~These workshops have resulted in four published and one unpublished meta-analyses since 1994~~
5011 ~~(Burnham et al. 1994, 1996, Anthony et al. 2006, and Forsman et al. 2011).~~ These analyses show that in
5012 areas where Barred Owls are present, the decline in Northern Spotted Owl abundance has been steeper
5013 than where the Barred Owl was absent. Declines were more prevalent where Barred Owls density was
5014 greatest. In addition, analyses determined that Northern Spotted Owl adult survival declined in a
5015 majority of the study areas in Washington, Oregon, and California where Barred Owls were present,
5016 with a more gradual decline in California sites (Forsman et al. 2011). The relatively lower rate of decline
5017 in California may be attributable to the relatively more recent Barred Owl expansion into California. The
5018 presence of Barred Owls in or near Spotted Owl territories appears to be impacting the abundance,
5019 fecundity, and survival of Spotted Owls (Olson et al. 2004, ~~Forsman et al. 2011~~ Dugger et al. In press).
5020 Wiens et al. (2014) found annual survival for Northern Spotted Owl in western Oregon lower (0.81,
5021 SE=0.05) than that of Barred Owl (0.92, SE=0.04), with a strong positive relationship on survival to old
5022 forests (>120 years) for both species. Northern Spotted Owl reproduction increased linearly with
5023 increasing distance from Barred Owl territory centers, and all Northern Spotted Owl nests failed when
5024 within 1.5 km (0.93 miles) of a Barred Owl nest (Wiens et al. 2014).

Comment [LVD124]: 128. This was described in detail previously.

Comment [LVD125]: 129. Update with the results from Dugger et al. In press.

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~~The expansion of the Barred Owl range into that of the Spotted Owl has been documented mainly through incidental detections during Spotted Owl surveys. Based on these detections, numerous researchers have reported that Barred Owl numbers quickly increase after a short period of slow increase once they arrive in a new area (USFWS 2013). In the Oregon Cascades, Barred Owl detections increased from one initial detection in 1979 to over 700 detections by 1998 (Kelly 2001). Barred Owls can also quickly outnumber Spotted Owls; in the Northern Cascades in Washington, Barred Owl abundance was twice that of Spotted Owls within 17 years of the first detection (Hamer et al. 1988). In the range of the Spotted Owl, the density of Barred Owls is greatest in the north, where they have been present the longest (British Columbia and Washington), and fewer detections have been made in the southern edge of the range (California) where they have been present for a shorter duration (USFWS 2013). Despite this general north-south gradient in the density of Barred Owls, Forsman et al. (2011) provide strong evidence of increasing Barred Owl populations throughout the range of the Northern Spotted Owl and California Spotted Owl.~~

~~Barred Owl presence has also been determined to be negatively associated with Spotted Owl occupancy throughout the range of the Northern Spotted Owl (Olson et al. 2005, Kroll et al. 2010, Forsman et al. 2011, Sovern et al. 2014). Studies have shown that Barred Owl presence influences whether Spotted Owls occupy a territory (Kelly 2001, Pearson and Livezey 2003, Gremel 2005, Sovern et al. 2014). In Olympic National Park, an area with historic Northern Spotted Owl territories, occupancy of Spotted Owls declined by almost 20 percent as Barred Owl presence increased by 15 percent between 1992 and 2003 (Gremel 2005). It has also been determined that Spotted Owls will move activities away from areas with Barred Owl presence even if they do not move their territory (Kelly 2001, Gremel 2005). Within the Hoopa Valley Indian Reservation (Humboldt County, California), Barred Owls were detected in over 85% of all historic Northern Spotted Owl territories between 2009 and 2014 (Higley and Mendia 2013). Northern Spotted Owl occupancy in the Hoopa study area started a steep decline in 2004, in concert with a boom in Barred Owl occupancy; and in 2013, Northern Spotted Owl occupancy was down to 0.595 while Barred Owl occupancy increased to 0.838 (95% CI) (Higley and Mendia 2013).~~

For the Willow Creek Study Area (part of the NWC study area), Franklin et al. (2015) reported a mean λ of 0.975 (1985-2014; SE 0.012), indicating a decline in the Northern Spotted Owl population for this area. The mean survival rate was 0.848 (1985-2014; SE 0.009). Survival rate was thought to be negatively influenced by the presence of Barred Owl. The Willow Creek Study Area has experienced a dramatic increase in Barred Owl detections, from one barred owl site in 1991 to 22 in 2014 (Franklin et al. 2015). Spotted Owl territories having Barred Owl detections ranged between 0-37 within the same timeframe (Franklin et al. 2015).

~~When Barred Owls were first detected in a Northern Spotted Owl territory on Green Diamond Resource Company land, Humboldt County, in 1989 with a slow increase until approximately 2000. Northern Spotted Owls no longer responded to taped playback calls, demonstrating they were either absent from the territory or not responsive (Diller 2012). In 2014, there were 268 Barred Owl detections on Green Diamond Resource Company land, representing an estimated 65 territories, and demonstrates which represented a 76% increase in detections from 2011-2014 (GDRC 2015). Forty-eight of the 65 territories were within the density study area (GDRC 2015).~~

Comment [LVD126]: 130. Move to the start of the section.

Comment [LVD127]: 131. This statement doesn't make sense to me. Certainly, we have documented NSO that went silent, but it was only a small proportion of all the owls in the study area.

Comment [LVD128]: 132. I'm not sure this has much relevance to the barred owl issue

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5065 Barred Owl removal experiments were conducted on Green Diamond Resource Company land to assess
5066 the impacts Barred Owls were having on Northern Spotted Owl presence (Diller 2012 and GDRC 2015).
5067 When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within
5068 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that
5069 some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to
5070 Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed
5071 (Diller 2012).
5072 During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley
5073 Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97%
5074 adults, 92.9% female, 65.3% male), with at least one Barred Owl removed from 28 historic Northern
5075 Spotted Owl territories, and >2 removed from 21 Northern Spotted Owl territories (Higley 2014).
5076 Spotted Owl occupancy since the removal has occurred has not yet been reported.

5077 Spotted Owls will reduce their calls or not call at all if Barred Owls are in the vicinity (Cozier et al. 2006,
5078 Diller 2012, Sovern et al. 2014), making it more difficult to detect Spotted Owls if Barred Owls are
5079 present. Thus, standard surveys might result in occupancy status being misclassified (e.g., a false
5080 negative survey—designating sites as unoccupied by Spotted Owls when in reality Spotted Owls are
5081 present but are not vocalizing). Beyond land management implications (e.g., timber harvest or not), this
5082 behavior shift by the Spotted Owl may also have implications for reproduction because calls are used to
5083 defend a territory and locate mates, and during pair bonding and prey delivery to the nest site (USFWS
5084 2013).

5085 The ecology of Barred Owls gives them a competitive advantage over Spotted Owls regarding
5086 reproductive success and productivity (Courtney et al. 2004, USFWS 2013). Barred Owls have larger
5087 clutches (1 to 5 chicks) than Spotted Owls (1 to 3 chicks), and individual females tend to breed every
5088 year compared to Spotted Owls that typically breed every other year and Barred Owls may produce up
5089 to three clutches per season, both of all of which may lead to higher productivity (Gutiérrez et al. 1995,
5090 Mazur et al. 2000, Gutiérrez et al. 2007, Wiens et al. 2014, Dugger et al. In press). Wiens et al. (2014)
5091 documented that pairs of Barred Owls produced an average of 4.4 times more young than pairs of
5092 Spotted Owls over a 3-year period in coastal Oregon. Some studies have found that Spotted Owls often
5093 do not breed every year, and that productivity varies from year to year (Forsman et al. 1984, Mazur et
5094 al. 2000, Rosenberg et al. 2003, Forsman et al. 2011).

5095 The literature suggests that Barred Owls are displacing Northern Spotted Owls from their territories, and
5096 Spotted Owls are forced into lower quality breeding and foraging habitat (USFWS 2013, Sovern et
5097 al. 2014). In addition, detecting Spotted Owls during surveys is likely hindered because Spotted Owls
5098 vocalize less often when Barred Owls are nearby (Crozier et al. 2006). Displacement and reduced
5099 vocalizations are thought to negatively impact Spotted Owl productivity (Forsman et al. 2011). As
5100 discussed previously, Barred Owls are prey generalists and Spotted Owls are prey specialists; a factor
5101 that may play into reproductive success (USFWS 2013).

5102 Both resident Barred Owls and Spotted Owls are highly territorial and have been shown to be
5103 approximately equal in their aggressiveness at attempting to repel a conspecific or closed related
5104 intruder into their territory (Van Lanen et al. 2011). However given their larger size, presumably Barred

Comment [LVD129]: 133. This is all about the initial efforts to experimentally document the impacts of barred owls on spotted owls and provide potential management options to address the threat. Furthermore, I think the results of the removal experiment should be moved to the end section rather than having it discussed in the middle of the section

Comment [LVD130]: 134. Move this paragraph to the beginning of the section.

Comment [LVD131]: 135. This can't be correct. The breeding phenology isn't all that different from spotted owls – it takes approximately 6 months from egg laying until the fledglings are completely independent for barred owls. Possibly there is evidence of barred owls attempting to re-nest up to 3 times following a nest failure, but there is no way they could even produce 2 clutches in a single season.

Comment [LVD132]: 136. Moved to below

Comment [LVD133]: 137. Already covered

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5105 Owls likely will be dominant in interspecific aggressive exchanges. Anecdotal observations of aggressive
5106 physical interactions between the two species have indicated that Barred Owls tend to dominate due to
5107 their larger size (Carlson 2015, Diller pers. comm.). Barred Owls are aggressive toward Spotted Owls,
5108 and have attacked Spotted Owls on occasion. Courtney et al. (2004) reported several instances where
5109 Spotted Owls were attacked by Barred Owls, and where surveyors were attacked by Barred Owls while
5110 playing Spotted Owl calls. Most Spotted Owl biologists do not believe that these physical encounters
5111 frequently result in serious injury to Spotted Owls, but Leskiw and Gutiérrez (1998) suspected that a
5112 Barred Owl killed and partially consumed a Spotted Owl. Johnston (2002, as cited by Courtney et al.
5113 2004) presented evidence that a Barred Owl likely killed a juvenile Spotted Owl. It is unclear if Barred
5114 Owls occasionally target Spotted Owls as prey, or if the documented mortalities were due to territorial
5115 aggression (USFWS 2013). By comparison, instances reported of Spotted Owl aggression toward Barred
5116 Owls are few (George and Lechleitner 1999, A. Ellingson, pers. comm, P. Loschl, pers. comm as cited in
5117 Courtney et al. 2004).

5118 This interspecific competition over territories indicates that Barred Owls are displacing Northern Spotted
5119 Owls from their territories, and Spotted Owls are forced into lower quality breeding and foraging habitat
5120 (USFWS 2013, Sovern et al.2014, Wiens et al. 2014). In possibly the best designed and implemented
5121 study of Barred Owl and Spotted Owl interactions to date, Wiens et al. (2014) concluded that Barred
5122 Owls were limiting the availability of old forests and associated prey species for Spotted Owls and this
5123 was the most strongly limiting factors in the competitive relationship between these species. In other
5124 words, the greatest impact of Barred Owls is to effectively act as a form of functional habitat loss for
5125 Spotted Owls.

5126 Lewicki et al. (2015) sampled blood from Northern Spotted Owls and western Barred Owls throughout
5127 Siskiyou, Trinity, Humboldt, and Mendocino counties in an attempt to evaluate parasite dynamics and
5128 the related impacts of Barred Owl range expansion on spotted owls. Specific results related to parasite
5129 prevalence are noted within the Disease section of this report below. The study suggests that parasite
5130 dynamics in Northern Spotted Owls are not solely influenced by the presence or absence of Barred
5131 Owls, but that more research is needed to assess roles of additional factors relating invasion to
5132 host/parasite dynamics (Lewicki et al. 2015).

5133 The literature suggests that Barred Owls have impacted Northern Spotted Owls in a variety of ways,
5134 including reduced detection rates, survival, fecundity and occupancy, but most importantly,
5135 displacement from and making unavailable essential habitat for roosting, nesting and possibly foraging,
5136 reduced detection rates, and predation. In the northern portion of the Northern Spotted Owl range,
5137 where Barred Owls have existed longer and are more densely distributed, the realized negative impacts
5138 are severe. In California, where Barred Owl occurrences are relatively recent, the negative impacts are
5139 less severe at this point. However, in portions of the northern California range where Barred Owls have
5140 become more common in recent years, impacts to Northern Spotted Owls, including displacement and
5141 declines in occupancy and survival rates, have been observed.

5142 A Barred Owl removal experiment was conducted on Green Diamond Resource Company land from
5143 2009 to 2014 to assess the impacts Barred Owls were having on Northern Spotted Owl presence. Green

Comment [LVD134]: 138. Peter Carlson reported on this at the Western Section TWS barred owl symposium and Green Diamond field crews have witnessed several physical attacks.

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Diamond's long term demographic study area was subdivided into treated areas (Barred Owls lethally removed) and untreated or control areas (Barred Owls undisturbed) to allow comparisons of spotted owl demographic parameters in treated and untreated areas before and after treatment (Diller et al. 2014, Dugger et al. In press). The study also quantified the effort, cost and effectiveness (i.e., how readily Barred Owls could be removed). The results of this initial study relative to feasibility and effectiveness indicated that barred owl removal was rapid, technically feasible, and cost-effective (Diller et al. 2014). Some of the results of the spotted owl population response to Barred Owl removal were reported in the most recent meta-analysis (Dugger et al. In press), but the full results of this study are in peer-review and currently unavailable (Diller et al. In review). Based on the results in Dugger et al. (In press), the removal of Barred Owls on the Green Diamond study area had rapid, positive effects on Northern Spotted Owl survival and rate of population change indicating Barred Owl removal may be able to slow or reverse Northern Spotted Owl population declines on at least a localized scale (Figure 30).

During the winter of 2013/2014, experimental Barred Owl Removal was initiated at Hoopa Valley Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97% adults, 92.9% female, 65.3% male), with at least one Barred Owl removed from 28 historic Northern Spotted Owl territories, and >2 removed from 21 Northern Spotted Owl territories (Higley 2014). Spotted Owl occupancy since the removal has occurred has not yet been reported.

Disease

The 2011 Revised Recovery Plan (USFWS 2011a) states, "It is unknown whether avian diseases such as West Nile virus (WNV), avian flu, or avian malaria... will significantly affect Spotted Owls." Likewise, disease occurrence in Spotted Owls is likely under-reported because Spotted Owls tend to inhabit remote areas and, therefore, there is a small likelihood of carcass recovery for testing (K. Rogers, personal communication, September 25, 2014).

In California, two studies have investigated the prevalence of WNV in raptor populations (Hull et al. 2006, Hull et al. 2010). In migrating and wintering hawks, Hull et al. (2006) found of the 271 red-tailed hawks, 19 red-shouldered hawks, and 30 Cooper's hawks tested, WNV antibodies were present in 5-58 percent. However, no individuals that tested positive demonstrated any visible signs of illness. Conversely, WNV antibodies were not detected in 62 Northern goshawks, 209 Spotted Owls, and 22 great gray owls sampled in the Sierra Nevada, suggesting low prevalence or high mortality in these species (Hull et al. 2010). Only one recent case of WNV infection was reported in a dead California Spotted Owl in 2013 from the Sierra Nevada (K. Rogers, personal communication, September 25, 2014).

Research conducted elsewhere in North America, suggests WNV infection causes morbidity and mortality in several species of raptors. In Colorado, WNV infection was highest in red-tailed hawks and great-horned owls (compared to other raptor species) admitted to wildlife rehabilitation centers; clinical signs were variable and included emaciation, weakness, and inability to perch, fly, or stand (Saito et al. 2007). Additionally, 40 of 56 dead raptors, evaluated for WNV, were positive; histological lesions most often included encephalitis and myocarditis (Saito et al. 2007). In Georgia, 40 out of 346 raptors tested for WNV were positive, including 4 Barred Owls, one great horned owl, and four eastern screech owls (Ellis et al. 2007). All 40 cases occurred during summer and late fall (Ellis et al. 2007), when mosquito

Comment [LVD135]: 139. This was submitted to the Journal of Wildlife Management in May 2015 and it should be accepted within the next couple of months.

Comment [LVD136]: 140. I think one of the key figures should be included from Dugger et al.)

Comment [LVD137]: 141. Alan Franklin collected blood samples from NSO on the Willow Creek Study Area and Green Diamond also provided samples to be tested for WNV. He also collected blood samples from small mammals and mosquitos to look for WNV. Apparently, Alan never published the results of this study, but it is my understanding that he didn't find any evidence of WNV in NSO. It would be useful to contact Alan to at least get the general results as a pers. comm.

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activity is most common. Gancz et al. (2004) investigated an outbreak of WNV in several species of captive owls in Ontario, Canada, including one Spotted Owl and eight Barred Owls. Owl species with more northerly breeding ranges (e.g., snowy owl, great gray owl) showed higher rates of infection than more southerly breeding species (e.g., barn owl, eastern screech owl) (Gancz et al. 2004). WNV infection in these captive birds was found to coincide with a summer louse fly infestation, suggesting bites from the louse flies aided in WNV transmission (Gancz et al. 2004). Additionally, there is evidence that raptors can become infected with WNV after feeding on infected prey (Nemeth et al 2006). WNV infection is routinely identified in squirrels (Family: Sciuridae) (Padgett et al. 2007), as well as jays and other songbirds (Hull et al. 2010; Wheeler et al. 2009) in California; the range of these species may overlap with that of Northern Spotted Owls, possibly posing an additional infection risk.

Other diseases that may impact Spotted Owls are largely unknown at this time. There are no known studies or cases of mortality caused by avian (flu) influenza in Spotted Owls. According to Rogers pers comm. (2014), prevalence of avian influenza in the spotted population is expected to be low since the disease is primarily carried by waterfowl and shorebirds, two groups that have low interaction with Spotted Owls. In addition, little information is available on the prevalence of avian malaria or Leucocytozoonosis (both blood parasites) in Spotted Owls. Significant mortality due to avian malaria or Leucocytozoonosis is rarely reported in avian species (K. Rogers, personal communication, September 25, 2014), with the exception of island endemics or birds in captive situations and most infected birds seem to recover or may have chronic infections. Impacts of parasitic infection to Northern Spotted Owl survival are also unknown. However, Martinez et al. (2010), documented lowered survival of wild-breeding female blue tits (*Cyanistes caeruleus*) in Spain infected with *Haemoproteus* parasites (*Haemoproteus* and *Leucocytozoon* spp.).

There are a handful of studies that have documented blood and intestinal parasites in owl species. Ishak et al. (2008) tested 111 Spotted Owls, and 44 Barred Owls, and 387 owls of nine other species for Leucocytozoon, Plasmodium, and Haemoproteus spp. (haemosporidian blood parasites). The study found both California and Northern Spotted Owls carried the greatest number of Leucocytozoon parasite lineages, California Spotted Owls had a higher prevalence of infection with more multiple infections than Northern Spotted Owl, and Barred Owls along the coast had lower rate of infection (15%) than Northern Spotted Owls (52%) and California Spotted Owls (79%). They suggested that the greater infection load of Spotted Owls compared to Barred Owls may favor the later in competitive interactions. Interestingly, Ishak et al (2008) documented the first ever case of Plasmodium infection in a Northern Spotted Owl. Gutiérrez (1989) tested 105 Spotted Owls (seven populations and all subspecies) for hematozoa (a blood parasite) and found all to be infected with at least one hematozoan. This study suggested that the owls large home range, spanning various forest types, the time spent caring for and provisioning young, and their long life span make this species more susceptible to higher rate of infection compared to other bird species (Gutiérrez 1989). From 2008 to 2012 blood samples were analyzed from Northern Spotted Owls (n=98) and western Barred Owls (n=49) throughout Siskiyou, Trinity, Humboldt, and Mendocino counties and tested for blood parasite loads (Lewicki et al. 2015). For comparison, blood samples were also analyzed from eastern Barred Owls (n=135) housed in wildlife rehabilitation centers throughout their historic range. Lewicki et al. (2015) found *Haemoproteus* spp.

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infection prevalence higher in Northern Spotted Owl (76.5%) than western Barred Owl (30.6%), and highest in eastern Barred Owl (88.1%), and infection intensity was nearly 100 times greater in Northern Spotted Owl than western Barred Owl. The study did not directly evaluate the impacts of blood parasite infections on the owl species assessed (Lewicki et al. 2015).

In Oregon, Hoberg et al. (1993) reported enteric coccidia (intestinal parasite) in a juvenile female Northern Spotted Owl. The presence of the parasite did not appear to contribute to the juvenile Spotted Owl's death; however, death has been attributed to this type of parasite in other raptor species (Hoberg et al. 1993). In this case study, transmission was thought to be through consumption of infected small mammal prey (e.g., mice, squirrels, woodrats). Trichomonosis is a concern for Spotted Owls if they consume Columbids infected with the protozoan parasite, *Trichomonas gallinae*, where species ranges overlap. The Department's Wildlife Investigation Lab documented two cases of Trichomonosis in California Spotted Owl in 2012, two cases in Northern Spotted Owl in 2014 from the Coastal Mountain Range, north of San Francisco Bay, and one in a great gray owl in 2006 and in 2007 (K. Rogers, personal communication, September 25, 2014).

In northwestern California, Young et al. (1993) found Hippoboscids flies on 62 of the 382 Northern Spotted Owls captured over five years between April and September, with higher prevalence in adults than juveniles. The flies were more abundant in years when fall temperatures were high, winter precipitation were low, and summer temperatures were low, suggesting fly abundance is climate dependent. Consequently, the frequency of Hippoboscids flies in the Northern Spotted Owls population may vary in intensity as climate changes (Young et al. 1993).

To address the shortfall of information on disease impacts to Spotted Owls, Recovery Action 17 of the 2011 Recovery Plan is, "Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, Plasmodium spp.) and address as necessary" (USFWS 2011a). In addition, the Department's Wildlife Investigation Lab is currently conducting a raptor disease and contaminant surveillance study that will help determine disease occurrence and contaminant exposure in raptor populations statewide, including both Northern and California Spotted Owls. This study will include targeted surveillance for a wide array of diseases and contaminants such as, WNV, mange, Avian Trichomonosis, Avian Chlamydiosis, and Avian Herpesvirus, AR and lead poisoning.

Contaminants

As described above (see [Habitat Loss from Marijuana Cultivation](#)), ~~in~~ [illegal marijuana grows are widespread in the Northern Spotted Owl range](#). ~~g~~ [Growers typically apply second generation anticoagulant rodenticides \(ARs\) at the base of plants to prevent small mammals from damaging the crop \(Thompson et al. 2013, Gabriel et al 2013\). These 2nd generation rodenticides present a risk to predators of small mammals, such as the Northern Spotted Owl, because this type of rodenticide is more acutely toxic, and persists in tissues and in the environment \(Gabriel et al. 2013\).](#) Northern Spotted Owls feed on a variety of prey species, but mainly small mammals make up a bulk of their diet. Consequently, the main contaminant threat to the owls is anticoagulant rodenticide poisoning. The anticoagulant rodenticides (ARs) are grouped into first-generation compounds (diphacinone,

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5263 chlorophacinone and warfarin), requiring several doses to target species before death occurs, and
5264 second-generation ARs (SGARs; e.g., bromadiolone, brodifacoum, difenacoum and difethalone),
5265 requiring only a single dose. Second generation ARs are more acutely toxic and persist in tissues and in
5266 the environment (Gabriel et al. 2013).

5267 Numerous field monitoring studies on other raptor and owl species indicate lethal and sublethal impacts
5268 of AR exposure (Mendenhall and Pank 1980, Stone et al. 2003, Walker et al. 2008, Albert et al. 2009,
5269 Murray 2011, Thomas et al. 2011, Christensen et al. 2012, Sánchez-Barbudo et al. 2012). In California,
5270 Lima and Salmon (2010) analyzed tissues from 96 raptors of 10 species brought to wildlife rehabilitation
5271 centers in San Diego and the Central Valley, and found that 69% (Central Valley) to 92% (San Diego) had
5272 been exposed to anticoagulant rodenticides. In Massachusetts, Murray (2011) tested 161 wild Red-
5273 tailed Hawks, Barred Owls, Eastern Screech Owls (*Megascops asio*), and Great Horned Owls and found
5274 86 percent with ARs in liver tissue, of which 99 percent was brodifacoum, a SGAR. Another study in New
5275 York found ARs present in 49 percent of wild raptors tested (n=265; 12 species), most prevalent in Great
5276 Horned Owls (43/53; 81%) and less prevalent in Barred Owls (3/13; 23%), with SGARs (brodifacoum and
5277 bromadiolone) being the most frequently detected (Stone et al. 2003). Nine of the 53 Great Horned
5278 Owls and one of the 13 Barred Owls died in this study, revealing a mortality rate of 17 percent and 8
5279 percent, respectively (Stone et al. 2003).

5280 In addition to the field monitoring that demonstrates widespread exposure of raptor/owl species to ARs,
5281 investigations of wildlife mortality incidents show that raptors comprise two-thirds of the anticoagulant-
5282 related wildlife mortalities (Department's Wildlife Investigation Lab files). These incidents are most likely
5283 to be reported in more populated areas, but it is reasonable to assume that any area where ARs are
5284 used for outdoor rodent control would share a similar pattern. The Department's Wildlife Investigation
5285 Lab documented several recent cases of AR poisoning for the California Spotted Owl (K. Rogers, personal
5286 communication, September 25, 2014); two cases in 2013, and two in 2014. However, at this time it is
5287 unknown how widespread morbidity and mortality is for the spotted owl population in California. As
5288 mentioned above, the Wildlife Investigation Lab is currently conducting a statewide raptor disease and
5289 contaminant surveillance study that will target AR occurrence in raptor populations to help shed light on
5290 the extent of this threat.

5291 Few laboratory studies have been conducted that test impacts of ARs on raptors, and no known studies
5292 have evaluated impacts on spotted owls. In a laboratory study by Mendenhall and Pank (1980), three
5293 species of captive owls fed mice or rats killed with the ARs bromadiolone, brodifacoum, or diphacinone
5294 (SGARs) died of hemorrhaging, those fed mice or rats killed with difenacoum (SGAR) displayed sublethal
5295 hemorrhaging, and those fed mice or rats killed with fumarin or chlorophacinone (1st generation ARs)
5296 displayed no signs of illness. Eastern Screech Owls were fed diphacinone for 7 days in a laboratory
5297 setting and monitored for 21-days post exposure (Rattner et al. 2013). This study found that toxicity
5298 appeared quickly upon exposure to lethal levels, but returned rapidly to normal in most owls after
5299 exposure was terminated (Rattner et al. 2013).

5300 Bond et al. (2013), notes the use of rodenticides (prevents damage to young trees from rodents
5301 browsing) or herbicides (suppresses shrubs to allow growth of trees) in burned forests and the potential

Comment [LVD138]: 142. You should insert the results from presentations at the Western Section TWS barred owl and marijuana symposia. There are data available on the proportion of barred owls from Hoopa and Green Diamond's study area with exposure to ARs. These data are the best surrogate for what is likely happening to NSO. Mourad Gabriel could provide the latest on this study.

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threat of these substances to Spotted Owls. The use of herbicides and rodenticides may reduce the prey habitat and abundance for Spotted Owls, however it is unlikely the activity would be a major source of rodenticide exposure for owls because the type of poison used are generally 1st generation anticoagulant rodenticides, which are not as persistent or toxic in their target species (S. McMillin, personal communication, September 25, 2014).

~~In illegal marijuana grows, widespread in the Northern Spotted Owl range, growers typically apply second generation AR at the base of plants to prevent small mammals from damaging the crop (Thompson et al. 2013, Gabriel et al. 2013). These 2nd generation rodenticides present a risk to predators of small mammals, such as the Northern Spotted Owl, because this type of rodenticide is more acutely toxic, and persists in tissues and in the environment (Gabriel et al. 2013).~~

The fisher is a species whose range and prey base overlaps with the Northern Spotted Owl (Zielinski et al. 1999, Zielinski et al. 2004), thus, the impacts of rodenticides in fisher may also be an impact to Northern Spotted Owl. Thompson et al. (2013) studied impacts of ARs to fishers in the southern Sierra Nevada and found impacts of ARs in association with illegal marijuana grows significant. Toxicants found at grow sites within the study area included brodifacoum and bromadiolone (SGARs), carbofuran (a pesticide currently banned in the United States), and malathion (an insecticide). Thirty-nine out of 46 fisher carcasses recovered (88%) tested positive for one of more AR compound with brodifacoum being the most common (Thompson et al. 2013). Another fisher study in California's Sierra Nevada found 79 percent of fisher carcasses (n=58) tested were exposed to ARs, and of that, 96 percent were exposed to SGAR compounds (Gabriel et al. 2013). Given these results, and the presumed extent of illegal marijuana grows in California (Gabriel et al. 2013, Thompson et al. 2013), it is likely that exposure to AR prevalence is widespread and is impacting Northern Spotted Owls in California to some extent. However, the effects and prevalence of poisoning events on overall fitness (e.g., survival and fecundity) remains unknown.

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytophthora ramorum*) which infects a variety of species. It is particularly lethal to tanoaks (*Lithocarpus densiflorus*) and several species of true oaks (*Quercus* spp.). In other species it may cause dead bark, leaf blight, and twig dieback (Shaw 2007, USFWS 2011a), and some hosts may be asymptomatic. Nearly all tree species in mixed evergreen and redwood-tanoak forest types may be hosts (Davidson et al. 2003, Garbelotto et al. 2003). According to Goheen et al. (2006),

“The pathogen has a wide host range including Douglas-fir, grand fir, coast redwood, and many other tree and shrub species common in Oregon and Washington forests. Tree mortality, branch and shoot dieback, and leaf spots result from infection depending on host species and location. *Phytophthora ramorum* spreads aerily by wind and wind-driven rain and moves within forest canopies and tree tops to stems and shrubs and from understory shrubs to overstory trees. The pathogen survives in infected plant material, litter, soil, and water. It is moved long distances in nursery stock... State and Federal personnel regularly survey forests and nurseries in the Pacific Northwest to detect the disease.”

Comment [LVD139]: 143. The 40% exposure was the exposure rate on Green Diamond's study area where regular patrols limit the number and size of illegal grows. On Hoopa, the exposure rate was significantly higher at 62%.

Comment [A140]: 144. Note to external reviewers: A publication is in the works to assess the potential impacts of ARs associated with marijuana plants to spotted owls, using barred owls as a surrogate. An abstract regarding this work, noted that the study found 40% of all Barred Owls tested were exposed to ARs in suitable NSO habitat within managed timberland in NW CA. The full analysis and result write-up are underway. Information from this effort will likely inform us on exposure to and impacts of ARs to owl fitness. This information will have to be added after external review, assuming it is ready prior to submission of this report to the Fish and Game Commission.

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5340 In 1995, sudden oak death was discovered in California within Mill Valley (Marin County), and has since
5341 spread across multiple coastal counties impacting coastal live oaks and tanoak forests within (Tietje et
5342 al. 2005). According to recent submission to the GIS tool “OakMapper”, confirmed locations of *P.*
5343 *ramorum* in California range from the coastal ranges in Monterey County and north up through portions
5344 of Humboldt County (California Oak Mortality Task Force 2015). Many studies have documented the
5345 widespread damage and mortality of oak-tanoaks coastal woodlands from Humboldt to Monterey
5346 counties (Rizzo and Garbelotto 2003, McPherson et al. 2005, Goheen et al. 2006, Cobb et al. 2009, Cobb
5347 et al. 2012). Shaw (2007) indicated that the disease in California is likely linked to coastal climates that
5348 are typically warmer and wetter than more inland forest types. There is large-scale concern regarding
5349 the impacts of this disease on forest structure and composition in California, and the associated impacts
5350 to wildlife species that inhabit these forests.

5351 Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases
5352 quickly. Cobb et al. (2009) examined mortality caused by sudden oak death within coastal redwood
5353 forests from Sonoma to Monterey counties. Tanoaks confirmed to be infected died on average within 1-
5354 6 years, and larger trees that were close to other infected species, such as the California bay laurel
5355 (*Umbellularia californica*), were infected to a greater extent than smaller, more remote trees. Tanoaks
5356 survived longer within redwood and Douglas-fir dominated forests than in hardwood dominated stands
5357 (Cobb et al. 2009). In Marin County, McPherson et al. (2010) examined the survival of coast live oaks,
5358 black oaks (*Q. kelloggii*) and tanoaks once infected by sudden oak death. The study found that live oak
5359 and tanoak survival declined as a function of disease state. Coast live oak survival was 11.7 to 15.8 years
5360 for asymptomatic trees; 7.5 to 11.7 years for trees bleeding only; and 2.6 to 3.4 years for trees bleeding
5361 with ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010). Tanoak survival was 8.8
5362 years for asymptomatic trees; 5.9 years for trees bleeding only; and 1.7 years for trees bleeding with
5363 ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010).

5364 After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi
5365 and insects is common and impacts survival times. For example, McPherson et al. (2005) found
5366 symptomatic progression and eventual mortality of coast live oaks and black oaks due to sudden oak
5367 death followed a similar sequence: bleeding, beetle colonization, emergence of *Hyposylon thouarsianum*
5368 (another fungal infection), and then death. Here, approximately 50% of bleeding live oaks were infected
5369 by ambrosia beetles and bark beetles, or showed evidence of past beetle infestation, whereas beetles
5370 infested tanoaks with less frequency (McPherson et al. 2005).

5371 It is unlikely that the impact of sudden oak death on oak-tanoak forests will subside in the future. Brown
5372 and Allen-Diaz (2005) examined past, current and future changes of coast live oaks-bay laurel woodland
5373 structure and composition within the San Francisco Bay Area due to sudden oak death infections. There
5374 was a 2-27% loss of coast live oak basal area (m²/ha) during the study period (2002-2004), a 4-55% loss
5375 in the recent past (5-10 years prior to 2002) through 2004, and a projected 15-69% coast live oak basal
5376 area loss in the future, with a total stand basal area was predicted to decrease up to 42% within the next
5377 5 years (Brown and Allen-Diaz 2005). Meentemeyer et al. (2009) predicted that with no control
5378 measures, sudden oak death will increase by 10-fold by 2030, particularly along the coast north of San
5379 Francisco. The model suggests that wet weather conditions exacerbated by predicted change climate

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5380 regimes serve to double the rate of spread in California (Meentemeyer et al. 2009). Predictive models
5381 note forests at high risk to sudden oak death in California occur in coastal forests of Santa Barbara
5382 County north through Humboldt County (Koch and Smith 2012).

5383 Oak-tanoak forests are present within the Northern Spotted Owl range in California and are an
5384 important component to owl habitat (see Habitat Section of this report). Oak and tanoak forest types
5385 and as elements within conifer forest provide habitat for the owl's main prey base, the dusky-footed
5386 woodrat, as well as other small mammals that comprise a smaller component of the owl's diet. There
5387 are no known published work evaluating the wildlife consequences of sudden oak death focus on
5388 impacts to Northern Spotted Owl habitat; however, results from these studies may inform potential or
5389 likely impacts of sudden oak death the species given what we know about owl habitat and prey needs.

5390 Within an infected study site in on Marin County, Temple and Tietje (2005) found coarse woody debris,
5391 a habitat component important for many small mammals, was 70 times higher than on an uninfected
5392 plot in Sonoma County, a difference supposedly due to sudden oak death-induced coarse woody debris
5393 generation. Within San Luis Obispo County, an area where sudden oak death has a low prevalence,
5394 areas in "high-risk" woodlands (i.e., those with species composition thought to be most impacted by
5395 sudden oak death) small mammals, including the dusky-footed woodrat, were more abundant (Tempe
5396 et al. 2005, Temple and Tietje 2005). The difference in species abundance between the sites is likely
5397 inherent, the authors' link to sudden oak death impacts of the comparison is unclear. However, these
5398 studies speculate that California bay laurel may replace coast live oak trees in the forest canopy. While
5399 having ecological importance, California bay laurel is relatively less productive than oaks as a wildlife
5400 habitat component.

5401 Only one study has provided any direct link to Spotted Owl occupancy and habitat impacts due to
5402 sudden oak death. Within Big Sur forests of California, Holland et al. (2009) indicated that California
5403 Spotted Owl were more likely to occur in forests with greater amount of tree mortality, suggesting
5404 sudden oak death could benefit owls in the short-term by generating coarse woody debris (e.g., downed
5405 logs and branches), key habitat features for the owl's prey resources. However, over the long-term,
5406 coarse woody debris and snags will decay and the supply will diminish thus prey resources may decrease
5407 and thereby impacting habitat suitability for the owls.

5408 More generally, several studies indicate an impact on small mammal populations associated with
5409 sudden oak death infestations within coastal forests, but do not provide a link between Spotted Owl
5410 occupancy. Several studies suggested that that woodrats and mice (*Peromyscus* spp.) may benefit from
5411 immediate changes in habitat features (e.g., increase in coarse woody debris, increased shrub cover)
5412 within infected areas; however long-term abundance is less certain in the face of continued sudden oak
5413 death infection (Apigian et al. 2005, Temple and Tietje 2005).

5414 The 2011 Northern Spotted Owl Recovery Plan (USFWS 2011a) notes this disease as a potential threat
5415 "due to its potential impact on forest dynamics and alteration of key prey and Spotted Owl habitat
5416 components (e.g., hardwood trees, canopy closure, and nest tree mortality)... especially in the southern
5417 portion of the Spotted Owl's range (Courtney et al. 2004)." However, the USFWS (2011a) asserted that

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the extent of the impact of sudden oak death to owl habitat, prey species, and occupancy has not been thoroughly assessed. To address the shortfall of information, Recovery Action 17 of the 2011 Recovery Plan is to “Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, Plasmodium spp.) and address as necessary” (USFWS 2011a). Monitoring techniques have been developed and may consist of regular aerial and ground surveys to assess rate of sudden oak death infection within oak-tanoak forest communities (Mai et al. 2005). However, such monitoring will detect spread well after a local invasion is established. Early detection techniques, such as eDNA sampling, may allow quicker intervention, but the efficacy of the various methods (Cobb et al 2013) still needs thorough evaluation.

Predation

The 2011 Revised Recovery Plan (USFWS 2011a) states,

“Known predators of Spotted Owls are limited to great horned owls (Forsman et al. 1984), and, possibly, barred owls (Leskiw and Gutiérrez 1998). Other suspected predators include northern goshawks, red-tailed hawks, and other raptors (Courtney et al.2004). Occasional predation of Spotted Owls by these raptors is not considered to be a threat to Spotted Owl populations, so no criteria or actions are identified.”

No new information has been generated since this statement was made, and therefore, the threat of predation to Northern Spotted Owls remains negligible.

Recreational Activities

Natural stress events (predator interactions, precipitous weather, disease, care of young), or anthropogenic stress events (vehicle traffic and noise, hikers) can impact species on multiple levels. This may include physiological impacts such as suppressed reproduction and growth (REFS), or behavioral responses such as avoidance (e.g., vocalizations and flushing).

Collecting and analyzing fecal samples has been shown to be effective at detecting stress hormone production (e.g., glucocorticoids) in owls (Wasser and Hunt 2005). By employing this methodology, a study conducted in the Shasta Trinity and Mendocino National Forests, California, found Northern Spotted Owls exhibit more stress when exposed to motorcycle activities, and exhibit lower reproductive success when exposed to busy roads (Hayward et al. 2014). Wasser et al. (1997) collected fecal samples from wild Northern Spotted Owl in Washington to measures stress hormone production in relation to timber activities (e.g., logging roads timber management). Males showed a more prominent increase in corticosterone production when the disturbance occurred with 0.41 km (0.25 miles) of the home range center, and in males whose home ranges were close to clear-cut (vs. selective logging).

Presence of hikers has been shown to alter owl behavior at roosting and nesting sites. Stwarthout and Steidl (2001) found that juvenile and adult Mexican Spotted Owls were less likely to flush from the presence of a hiker at 212 and 224 meters, respectively, and neither juveniles nor adults were likely to alter behavior at distances 255 meter or more. At nesting territories, Mexican Spotted Owls in Utah

Comment [LVD141]: 145. We collected NSO fecal pellets for Sam Wasser, but he never published the results because our owls living on a managed landscape had low levels of corticosteroids, which didn't fit with his hypothesis.

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5453 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance
5454 with the presence of hikers (Swarthout and Steidl 2003).

5455 It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the
5456 level to which these activities may impact owl behavior, reproduction and overall survival has yet to be
5457 determined. It is unlikely anthropogenic stress events associated with recreation will impact Northern
5458 Spotted Owl reproduction and survival to any great extent, though further research is warranted.

5459 **Loss of Genetic Variation**

5460 There had previously been little evidence in the literature of loss of genetic variation and population
5461 bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across
5462 the range of the Northern Spotted Owl provides compelling evidence that a population bottleneck may
5463 have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from
5464 352 Northern Spotted Owls from six regions across the range which included limited samples from the
5465 northern portion of the California Klamath Province.

5466 Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades)
5467 bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant
5468 evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest
5469 California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic
5470 variation and hence effective population size, do not necessarily indicate a decline in actual
5471 (demographic) population size (Funk et al. 2010) "... it is important to keep in mind that
5472 reductions in [effective population size] (detected with bottleneck tests) are different than
5473 reductions in demographic population size (detected with demographic field studies) and
5474 reductions in one of these parameters does not necessarily result in a change in the other."
5475 (Funk et al. 2010)

5476 The scientific review of the Draft Recovery Plan Recovery was able to review unpublished genetic
5477 studies from Dr. Susan Haig (Courtney et al. 2008). Using samples collected from 352 owls, the results
5478 provided some evidence that recent bottlenecks have occurred at various spatial scales within the
5479 Northern Spotted Owl range, but could not definitively link the genetic declines to recent population
5480 declines (USFWS 2011a, Courtney et al. 2008). Geneticists ~~scientists~~ reviewing Haig's work concluded
5481 that the bottlenecks observed by Haig were likely the result of recent population declines rather than
5482 the cause of decline (Courtney et al. 2008). Specifically, Courtney et al. (2008) states,

5483 "The conclusion by Barrowclough and Coats (1985) is still appropriate here, which is that the
5484 population dynamics of the Spotted Owl likely will be more important to its short-term survival
5485 than will be its genetic makeup, regardless of the evidence for bottlenecks having occurred in
5486 the past. Our conclusions might warrant re-consideration at some future point, in the context of
5487 explicit evidence linking reductions in genetic diversity to current conditions, and current or
5488 future population performance. "

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Summary of Listing Factors

The California Endangered Species Act directs the Department to prepare this report regarding the status of the Northern Spotted Owl in California based upon the best scientific and other information available to the Department (Fish & G. Code, § 2074.6, subd. (a); Cal. Code Regs., tit. 14, § 670.1, subd. (f)). CESA’s implementing regulations identify key factors that are relevant to the Department’s analyses. Specifically, a “species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities.” (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and Game Code guide the Department’s scientific determination. An endangered species under CESA is one “which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease.” (Fish & G. Code, § 2062). A threatened species under CESA is one “that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA].” (*Id.*, § 2067).

The Department’s summary of listing factors are summarized below:

Present or threatened modification or destruction of habitat

Timber Harvest and Regulatory Considerations

Although the rate of nesting and roosting habitat loss has declined since the Northern Spotted Owl was listed under the federal endangered species act in 1990, assessments performed on rangewide since the implementation of the NWFP show that habitat loss is ongoing. Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and timber harvest has been the leading cause of habitat loss on nonfederal lands since 1994. Although state regulations governing timber harvest on nonfederal lands in California (i.e., California Forest Practice Rules) are the most protective state regulations in the range of the Northern Spotted Owl, losses of nesting and roosting habitat due to timber harvest in California have continued. Since 1994, 5.8% of nesting and roosting habitat on nonfederal lands in California has been removed by timber harvest.

California Forest Practice Rules

Minimum habitat retention requirements are identified in the Forest Practice Rules for timber harvest occurring on privately owned land in California. Definitions for the different habitat types to be retained are also included in Forest Practice Rules. Habitat Retention requirements and definitions were developed in the early 1990s and can be found in Table 20 and Appendix 2. Retention requirements were established for a combination of nesting, roosting, and foraging habitat in the area immediately

Comment [LVD142]: 146. There needs to be some recognition of the regrowth of nesting and roosting habitat in the last 20 years. At least on the coast, we have documented that owls are regularly nesting in 30-40 year old third growth with residual structure.

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5525 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the
5526 broader home range (1.3 mile radius).

5527 The most recent research on Northern Spotted Owl habitat requirements in California and southern
5528 Oregon have demonstrated a link between owl fitness and the amount of types of habitat, structural
5529 characteristics, and spatial configuration in a home range. This requirement for habitat heterogeneity is
5530 consistent with the general approach incorporated in the Forest Practice Rules. Although study design
5531 has varied across the major research studies, some consistent patterns have arisen. In order to support
5532 productive Spotted Owl territories, a minimum amount of older forest must be retained in the core
5533 area. The definition of 'older forest' evaluated in studies has varied, but consistently includes late-seral
5534 forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older
5535 forest in an approximately 400 acre core area.

5536 Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling
5537 cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness.
5538 Results indicate that in order to support a productive Northern Spotted Owl territory, no more than
5539 about 50% of a home range should consist of nonhabitat.

5540 The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations
5541 for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest
5542 Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls [in the northern](#)
5543 [interior region](#). The total acreage of recommended retention in the USFWS guidance does not differ
5544 from that found in the Forest Practice Rules, and is consistent with research indicating that about half of
5545 a Northern Spotted Owl home range must be retained in habitat. However, based on assessment of core
5546 use areas in the interior portion of the range, the USFW modified the retention of habitat in core use are
5547 to occur within 0.5 miles of an activity center, instead of the 0.7 mile radius in Forest Practice Rules. This
5548 brings the recommendations in line with core use areas evaluated in recent work. The most significant
5549 change in the revised USFWS recommendations was in the definitions of nesting, roosting, and foraging
5550 habitat and in the specific amount of each type to be retained. Although the types of forests used by
5551 Northern Spotted Owl for nesting, roosting, and foraging does vary, the USFWS requirement for the
5552 oldest forests to be retained near the core is consistent with the literature.

5553 A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised
5554 USFWS recommendations (see Table 22 for the interior portion of range in California) shows large
5555 discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under
5556 the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the
5557 USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
5558 This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500
5559 acres spotted owl habitat to be retained within 0.7 miles and the total of 1,336 acres to be retained
5560 within 1.3 miles of an activity center can be composed of functional foraging habitat under Forest
5561 Practice Rules, a definition that is considered low quality foraging habitat by the USFWS; therefore there
5562 is no requirement in the Forest Practice Rules for this habitat include nesting or roosting habitat under
5563 the Forest Practice Rules.

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5564 Our assessment of selected activity centers shows that the habitat retention guidance in the Forest
5565 Practice Rules are not always met, indicating that harvest is impacting Northern Spotted Owl at some
5566 locations. Of the activity centers evaluated, several experienced very high acreages of harvest at both
5567 the broad home range and in the core area, which would have resulted in territories that do not meet
5568 the USFWS recommendation for take avoidance, and would have resulted in declines in survival and
5569 fitness of the local owls.

5570 Documentation of habitat type, amount, and distribution present around activity centers after THPs are
5571 implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the
5572 Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if
5573 minimum retention requirements in the Forest Practice Rules are implemented as written, there is still
5574 the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated
5575 failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts
5576 that have occurred in recent years.

5577 The THP review and post-harvest follow-up process should ensure that the best scientific information is
5578 being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to
5579 which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a
5580 sample of activity centers indicates that it is not universally applied and that insufficient habitat has
5581 been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern
5582 Spotted Owl is likely to continue experiencing loss of habitat in California.

5583 Salvage Logging

5584 Several variables complicate the interpretation of owl response to fire, including variation in fire
5585 severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing
5586 and duration of research post-fire. Regardless, several studies have suggested that salvage logging after
5587 a fire or occurrence of extensive high severity burns likely have contributed to a decline in habitat use,
5588 occupancy, or survival of Northern Spotted Owls. Although hampered by small sample size, incidental
5589 observations have documented declines in occupancy of burned areas following salvage logging.
5590 Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction
5591 probabilities, although the impacts of salvage logging were observed only in combination with other
5592 factors.

5593 The presence of snags has been suggested as an important component of prey habitat and as perch sites
5594 for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub
5595 and herbaceous cover and number of snags, may be impacted by salvage logging.

5596 Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the
5597 fire itself, by removing important structural elements and removing important prey habitat. The
5598 available information suggests that salvage logging reduces the probability that spotted owls will use
5599 burned areas and has resulted in declines in occupancy, either through abandonment or declines in
5600 survival.

Comment [LVD143]: 147. I have no doubt that habitat is being lost at some NSO sites, but is that loss greater than regrowth in other areas? I am not sure how one would go about it, but if timber harvest on private lands is going to be considered a threat to the long term persistence of NSO, there needs to be some analysis to determine if regrowth of habitat is keeping pace with habitat loss. Of course, the greatest reality is that none of the habitat assessments will matter if the barred owl threat is not addressed. Barred owls are excluding NSO from habitat at a pace that exceeds anything that will ever be done with chainsaws.

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5601 *Wildfire*

5602 Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and
5603 wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994,
5604 after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to
5605 wildfire, and most of this loss has occurred in the Klamath Province.

Comment [LVD144]: 148. Same issue that regrowth of habitat is not being addressed.

5606 The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to
5607 use burned areas extensively, although nesting and roosting general occurred only in unburned or low-
5608 severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by
5609 California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in
5610 burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some
5611 evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

5612 Conversely, Northern Spotted Owls in southern Oregon were shown to have declines in occupancy
5613 following fire. These declines resulted from both high extinction rates in burned areas and low
5614 colonization rates.

5615 Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to
5616 experience declines in survival. Food limitation in burned areas may have been a factor in declining
5617 survival rates. These observed declines in southern Oregon may be confounded by the occurrence of
5618 post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl
5619 subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in
5620 the year following fire; these owls were not tracked to investigate potential longer-term effects.

5621 Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or
5622 areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance
5623 for foraging.

5624 The available information suggests that wildfires can have positive effects on Northern Spotted Owls
5625 when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without
5626 removing important nesting and roosting habitat components at the territory scale. However,
5627 uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating
5628 required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed
5629 in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be
5630 used as a management tool.

5631 Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California
5632 included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades,
5633 fires have become more frequent and average fire size has increased. In some cases fires have also
5634 burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry
5635 and hot conditions). Because climate change will likely increase the likelihood of conditions that support
5636 fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

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5637 Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue
5638 experiencing loss of habitat in California.

5639 *Climate Change Impacts to Forest Composition and Structure*

5640 Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate
5641 projection scenarios specific to California, the most notable response to increase temperature was a
5642 shift from conifer-dominated forests (e.g., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g.,
5643 Douglas fir-tan oak) in the northern half of the state), expansion of conifer forests into the northeast
5644 portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine
5645 forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-
5646 tan oak forests, and advancement of conifer-dominated forests (e.g., redwood and closed-cone pine
5647 forests) along the north-central coast. Tree productivity along California's north-central coastal and at
5648 high elevation forests may increase in response to increased growing season temperatures; however,
5649 reductions in summer fog in concert with increased temperatures may reduce productivity of redwood
5650 forests along the coast. In addition, the literature suggests that climate change variables will increase
5651 the severity and frequency of wildfires within the Northern Spotted Owl range.

Comment [LVD145]: 149. Not according to Steve Sillett's research

5652 Although climate projection models have uncertainties built-in, it is apparent from the literature that
5653 forests within California will likely experience some level of elevational and latitudinal shifts, changes in
5654 species composition, and alterations in fire regimes. For the Northern Spotted Owl, who has a heavy
5655 reliance on specific forest structure components and tree species composition, and associated prey
5656 habitat and abundance, implications of such forest shifts and fire regime changes may prove
5657 unfavorable to the species over time. During long-term landscape planning related to Northern Spotted
5658 Owls and their habitat, potential climate change impacts should be analyzed and incorporated.

Comment [LVD146]: 150. By its very nature, shifts in forests would suggest benefits to owls in some areas and negative impacts in others. What remains uncertain is if this will lead to overall reductions in the amount or quality of NSO habitat.

5659 *Other Mechanisms of Habitat Loss*

5660 Sudden Oak Death

5661 Sudden oak death syndrome is recognized as a potential threat to Northern Spotted Owls due to
5662 impacts on forest structure and composition, and consequently alteration of prey habitat and
5663 abundance. The disease is particularly lethal to tanoaks and several species of true oaks. Confirmed
5664 locations of sudden oak death in California range from the coastal ranges in Monterey County and north
5665 up through portions of Humboldt County. Portions of California coastal forests at a high risk of infection
5666 have been identified in Santa Barbara County north through Humboldt County.

5667 Predictive modeling studies indicate that the disease is projected to increase 10-fold by 2030 in
5668 California, which could be exacerbated by wetter weather conditions on the coast predicted by climate
5669 change models. Given this, there is concern over the potential impact of sudden oak death in California
5670 to Northern Spotted Owls in the future. For instance, oak-tanoak forests support the dusky-footed
5671 woodrat, one of the owl's main prey species, as well as other small mammals that comprise a smaller
5672 component of the diet. If abundance of prey is altered within the range of the Northern Spotted Owl
5673 due to decreases in oak-tanoak forests, negative impacts to owls will likely ensue.

Comment [LVD147]: 151. But the highest densities of dusky-footed woodrats occur in early seral redwood forests (Hamm 1995) so fewer tanoaks don't necessarily mean fewer woodrats. Total elimination of tanoaks would negatively impact owls through reduction in forest stand complexity, but a limited reduction in tanoaks could benefit forest complexity in areas totally dominated by tanoaks to the exclusion of conifers.

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Though no studies have yet evaluated the consequences of sudden oak death specific to Northern Spotted Owl habitat and fitness in California, there is evidence that habitat and prey abundance will be impacted in the face of this disease, and impacts will vary spatially and temporally. The literature suggests that short-term impacts may initially provide an increase in prey habitat and abundance, and thus may lead to an increased owl occupancy rate. However, this phenomenon will likely subside when habitat conditions deteriorate over time or tree species composition changes to a point the area can no longer support key owl prey species.

The extent of sudden oak death impacts to Northern Spotted Owl habitat, prey species, and occupancy needs to be thoroughly assessed. Early detection techniques should be explored and implemented within coastal California forests so that negative impacts can be realized and remediated, if possible.

Marijuana Cultivation

Illegal and legal marijuana cultivation in remote forests on public and private land throughout California has been on a steady increase. Within the range of the Northern Spotted Owl, Shasta, Tehama, Humboldt, Mendocino, and Trinity counties comprise the areas known for the most marijuana cultivation in California due to the remote and rugged nature of the land, making cultivation difficult to detect, and habitat conditions favorable for growing marijuana (e.g., wetter climate, rich soils). Given the difficulties in detecting both legal marijuana cultivation sites and the lack of reporting legal cultivation sites, actual distribution and density of marijuana cultivation is likely larger and higher than represented in datasets collected to date.

Activities associated with cultivation (e.g., removal of large trees, degradation of riparian habitat) may negatively impact Northern Spotted Owl habitat, though data on the extent of this impact is not well known. Areas with higher prevalence of marijuana cultivation may also contain high numbers of Northern Spotted Owl activity centers. The level of impact likely depends on several factors, including the density of cultivation sites in proximity to owl activity centers and how much owl habitat is affected and to what extent. Given that marijuana cultivation is on the rise in California, a thorough assessment of potential habitat impacts to Northern Spotted Owls should be implemented.

Abundance and Demographic Rates

Few studies have attempted to examine range-wide Northern Spotted Owl population estimates. Survey methodology and effort does not allow for reliable estimates across the range or within California, and does not effectively sample nonterritorial floater individuals. Northern Spotted Owl [population](#) densities vary across the range and forest types; therefore, extrapolating the few local estimates across the range of the subspecies would result in biased estimates of abundance. The Department's Spotted Owl Database houses a cumulative tally of all historic owl observations and activity centers, and for this reason it is inappropriate to use the Dataset as a surrogate for abundance and density estimates. The increase in number of activity centers over time is more likely the result of expanded survey effort than establishment of new activity centers. In addition, across most of the Northern Spotted Owl range establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a

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5711 slow process given tree species growth rate (with a possible exception on the coastal redwood forests),
5712 and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

5713 One recent study, modeling exercise made use of the immense amount of data available on Northern
5714 Spotted Owl habitat requirements and availability, home range sizes, age-specific survival rates, age-
5715 specific fecundity, dispersal behavior, and impacts of Barred Owl on survival, to model source-sink
5716 dynamics across the range of the owl. In addition to an evaluation of source-sink dynamics, outcomes of
5717 the model included a range-wide prediction of the potential population size capable of being supported
5718 based on model parameter estimate, and the proportion of the population capable of being supported
5719 in each modeling region and physiographic province noted in the 2011 USFWS Revised Northern Spotted
5720 Owl Recovery Plan. The study estimated-projected 3,400 female Northern Spotted Owls could be
5721 supported range-wide, with over 750 females in the Inner California Coast, Klamath East, Klamath West,
5722 Redwood Coast, and West Cascades South modeling regions. Three provinces located in California were
5723 estimated to contain projected to be capable of supporting over 50 percent of the range-wide Northern
5724 Spotted Owl population, with the Klamath region in Oregon and California being a potential stronghold
5725 for the population. Even though the complexity of the model may limit its ability to accurately model
5726 population estimates/projections, the results suggest that California's population of Northern Spotted
5727 Owls is has the potential to be an important component of the range-wide population.

Comment [LVD148]: 152. I think it is inappropriate to refer to a modeling exercise as a "study" which implies data were collected on owls.

5728 Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource
5729 Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for
5730 more than two decades to assess demographic parameters such as population growth, survival,
5731 fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study
5732 areas range-wide. In California, the most recent meta-analysis covering years 1985-2008-2013 reported
5733 a 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline
5734 per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the
5735 Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation
5736 study area reported a 2.3% population decline per year through 2012. When converting estimates for
5737 population change to estimates of realized population change (i.e., the proportional change in estimated
5738 population size relative to population size in the initial year of analysis) two study areas in California
5739 (Green Diamond Resource Company and Northwest California) showed estimated population declines of
5740 about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight
5741 decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary
5742 meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across
5743 the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The
5744 ongoing analysis has revealed declines in California between 32 and 55% over the study period.

Comment [LVD149]: 153. This is the first place the meta-analysis has been mentioned in the summary so it makes sense to briefly describe it here (i.e., principal investigators, biologists and a host of renowned statisticians and analyst periodically get together to analyze data from all the existing demographic study areas).

Comment [LVD150]: 154. Everything from here to the end of the section needs to be updated by replacing Forsman et al. (2011) results with Dugger et al. (in press).

5745 In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young
5746 produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged
5747 from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green
5748 Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian
5749 Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in

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5750 Washington and Oregon. Although less severe than in Washington and much of Oregon, all three
5751 California study areas show declines in survival.

5752 Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in
5753 California give us information on current estimates for reproductive success (number of young fledged
5754 per monitored site) and survival, and are consistent with a continued decline within all demographic
5755 study areas in California. In the coastal portion of the Northern Spotted Owl range in California, many
5756 areas reported consistently low reproductive success from 2011-2013, including some of the lowest
5757 reproductive success rates on record in 2013 despite weather conditions that would typically support
5758 good reproductive success. This was observed on many timber company lands, tribal lands, and National
5759 Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In
5760 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive
5761 rate since 2009.

5762 The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study
5763 areas in California reflected trends on non-federal lands because two study areas are on non-federal
5764 lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl
5765 habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal
5766 land. However, the authors also suggest that results depict an optimistic view of the overall population
5767 status of the Northern Spotted Owl on private lands because the non-federal lands included in the
5768 demographic study areas are managed for owls. Results from the demographic study areas are thought
5769 to be representative of federal lands and areas of mixed federal and private lands throughout the range
5770 of the Northern Spotted Owl because the study areas were large, distributed across a broad geographic
5771 region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

5772 Occupancy data is based on the presence or absence of owls from known sites. In order for estimates of
5773 occupancy to be valid, ~~survey efforts must be consistent over time and~~ the detection probability (the
5774 probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead
5775 to high variation in detection probability which can skew estimates of occupancy if not accounted for.
5776 Although an evaluation of occupancy rates has not been included in previous demographic meta-
5777 analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the
5778 number of territorial owls detected on all 11 areas was lower at the end of the study period than at the
5779 beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling
5780 for the first time. Preliminary results show that occupancy rates have declined at all three California
5781 study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on
5782 occupancy by increasing the local territory extinction rate.

5783 Occupancy has been shown to be in decline for areas outside the California demographic study areas as
5784 well. For example, the southern Cascades and interior Klamath provinces of California determined
5785 occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl
5786 declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

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5787 It is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of
5788 demographic rates across the range indicate the declines in demographic parameters, including
5789 population size, have accelerated. The level of decline does not seem to be slowing even with the
5790 implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at
5791 threats leading to these declines is warranted, including revaluation of the effectiveness or management
5792 techniques across the Northern Spotted Owl range in California.

5793 **Predation**

5794 Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-
5795 tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The
5796 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted
5797 Owls is not a threat to the population. In the case of documented Barred Owl aggression toward
5798 Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented
5799 mortalities were due to territorial aggression. Given that predation is not considered to be a major
5800 threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly
5801 manage predation issues.

5802 **Competition**

5803 Over the last several decades, Barred Owls have gradually moved further into the range of the Northern
5804 Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been
5805 present the longest (British Columbia and Washington), with fewer detections made in the southern
5806 edge of the range (California) where they have been present for a shorter duration. Currently, Barred
5807 Owls have been documented in all portions of the Northern Spotted Owl range throughout California,
5808 though densities of Barred Owls are unknown.

5809 Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to
5810 the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most
5811 important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat
5812 and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong
5813 indication that the two species can coexist over time, sharing the same habitat and prey-base, because
5814 there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and
5815 not by Barred Owls.

5816 ~~Public workshops held by the USFWS have resulted in four published and one unpublished meta-~~
5817 ~~analyses since 1994 to assess population parameters, such as abundance, trend, and survival. These~~
5818 analyses show that in areas where Barred Owls are present, the decline in Northern Spotted Owl
5819 abundance has been steeper than where the Barred Owl was absent. Declines have been more
5820 prevalent where Barred Owls density was greatest. Northern Spotted Owl adult survival has declined in
5821 a majority of the range where Barred Owls were present, with a more gradual decline noted in California
5822 largely attributed to the relatively more recent Barred Owl expansion into this portion of the range.
5823 Presence of Barred Owls in or near Northern Spotted Owl territories is also thought to negatively impact

Comment [LVD151]: 155. The meta-analysis process should be described above where it is first mentioned. BTW, it is not a public workshop – it is invitation only.

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fecundity, survival, and occupancy of Northern Spotted Owls. A recent study in coastal Oregon has shown that the strongly territorial behavior of both species results in competitive exclusion by the larger Barred Owl resulting in displacement of Northern Spotted Owls from their territories, forcing them into lower quality breeding and foraging habitat.

An Experimental studies to remove Barred Owls removal study conducted in coastal California demonstrated that Barred Owl removal was rapid, technically feasible and cost-effective. Based on the results of the most recent meta-analysis, the experimental removal had rapid, positive effects on Northern Spotted Owl survival and rate of population change indicating Barred Owl removal may be able to slow or reverse Northern Spotted Owl population declines on at least a localized scale Northern Spotted Owl occupancy decreases with Barred Owl presence and increases with Barred Owl removal, suggesting that Barred Owls are displacing Northern Spotted Owls from their territories, forcing them into lower quality breeding and foraging habitat.

Given the severity of impacts and the quick range expansion into California, Barred Owl is considered one of the major threats to Northern Spotted Owl populations in California. More research is needed to assess Northern Spotted Owl site occupancy, reproduction, and survival in the face of Barred Owl presence, including the implementation of experimental removal of Barred Owls. Resource partitioning between the two species also needs further investigations.

Disease

Several studies indicate that raptors, including Spotted Owls, may be impacted at some level by disease and insect infestations (e.g., West Nile Virus, avian influenza, avian malaria, Leucocytozoonosis, fly/mite infestations). The 2011 Northern Spotted Owl Revised Recovery Plan recognizes that disease threat is unknown, but may significantly impact owls. Disease occurrence in Northern Spotted Owls is likely under-reported because owls tend to inhabit remote areas and, therefore, there is a small likelihood of carcass recovery for testing. Disease may be a significant threat to Northern Spotted Owls, but more research is needed to better understand prevalence and magnitude of impacts in owl populations in California.

Other Natural Events or Human-related Activities

Precipitation and Temperature Changes

Most climate projection scenarios agree that the forests in the Northern Spotted Owl's range will have wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased frequency and intensity of disturbance events. According to many climate projections, the frequency and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will increase over time. Vulnerability to disturbance, such as wildfire, disease, and insect outbreaks, is expected to increase in most forests in the Northwest and may change forest composition and structure depending on changes to climate. Climate modeling studies agree that forest wildfire occurrence and

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5859 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced
5860 snowpack, earlier spring snowmelts, and longer drier summers.

5861 Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These
5862 studies indicate that winter precipitation is closely associated with a decrease in survival and
5863 recruitment; population growth was positively associated with wetter conditions during the growing
5864 season (May through October) and negatively associated with cold/wet winters and nesting seasons,
5865 and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction
5866 increased with late nesting season precipitation and decreased with warm temperatures; and owls may
5867 be more sensitive to changes in spring time climatic events.

5868 It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many
5869 climate projections forecasting steady changes in the future. Climate change studies predict future
5870 conditions that may negatively impact owls, such as wet and cold springs, more frequent and severe
5871 summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased
5872 frequency of severe wildfire events. Yet in some instances projected future conditions, such as increased
5873 frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to
5874 the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change
5875 predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other
5876 areas of the range. Looking at past precipitation and temperature trends, drying trends across most of
5877 the range coupled with warmer winters and cooler summers in the interior and cooler winters and
5878 warmer summers along the coast may play a role in both owl and prey population dynamics. More
5879 research is needed to assess the extent of these climate impacts on survival, population growth, and
5880 reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of
5881 climate change outweigh the positive ones.

5882 Climate change will likely impact the Northern Spotted Owl in California, but the degree to which it is a
5883 threat to the species continued existence in the short- or long -term needs further investigation. During
5884 long-term landscape planning related to Northern Spotted Owls and their habitat, potential climate
5885 change impacts should be analyzed and incorporated.

5886 *Recreational Activity*

5887 Relatively few studies have been conducted on the impact of recreational activity on Northern Spotted
5888 Owls. A few studies suggest that stress levels increase in individual Northern Spotted Owls when
5889 exposed to motorcycle activities, timber harvest activities, and presence of hikers. It is clear recreational
5890 activities impact Northern Spotted Owls to some extent, but the level to which these activities may
5891 impact owls has yet to be determined. It is unlikely anthropogenic stress events associated with
5892 recreation will impact Northern Spotted Owl reproduction and survival to any great extent, though
5893 further research is warranted.

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5894 *Loss of Genetic Variation*

5895 Loss of genetic variation is not considered to be a major threat to Northern Spotted Owls at this time.
5896 Some recent studies provide evidence that a population bottleneck may have occurred within the last
5897 few decades across the range of the Northern Spotted Owl; though no effect was documented for
5898 Northwest California.

5899 **Management Recommendations**

5900
5901 The goal of the Department is to secure recovery and long-term survival of the Northern Spotted Owl
5902 across their historic range. The Department has evaluated existing management measures and has
5903 identified the following management recommendations, listed in no particular order, as necessary to
5904 help achieve the aforementioned goal. Many of these recommendations are adapted from the USFWS
5905 Northern Spotted Owl Recovery Plan (USFWS 2011a) and are based on the best available scientific
5906 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where
5907 applicable. As new information becomes available, recommendations may be further refined.

5908 Planning and Timber Practices

- 5909 1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is
5910 consistent with the recovery of the species (see RA14).
- 5911 2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-
5912 range planning, setting priorities for scientific research and investigations, and/or when making
5913 major decisions affecting the Northern Spotted Owl (see RA5).
- 5914 3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative
5915 opportunities for nonfederal landowners to engage in management strategies (see RA15).
- 5916 4. Consider long-term maintenance of local forest management infrastructure as a priority in
5917 planning and land management decisions (see RA16).
- 5918 5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and
5919 contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of
5920 Northern Spotted Owls (see RA21).
- 5921 6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential
5922 recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in
5923 California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration,
5924 HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
- 5925 7. Improve thorough documentation of harvest prescription methods within timber harvest plans
5926 | and a rigorous evaluation-quantification of post-harvest levels of foraging, nesting, and roosting

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- 5927 | habitat and use those results in conjunction with field experiments to monitor the response of
5928 | Spotted Owls to various levels of post-harvest habitat retention.
- 5929 | 8. Evaluate-Experimentally test the effects of silvicultural practices on important prey species (e.g.,
5930 | flying squirrel, woodrat) and their habitat.
- 5931 | Population Trend and Demographic Parameters
- 5932 | 9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if
5933 | the California population is decreasing, stationary or increasing (see RA2).
- 5934 | 10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy
5935 | across its California range (see RA3).
- 5936 | 11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival,
5937 | population growth and reproductive rates of Northern Spotted Owls in California, and
5938 | determine if negative impacts of climate change outweigh the positive ones.
- 5939 | Habitat
- 5940 | 12. Manage Northern Spotted Owl habitat in a way that accelerates the development of structural
5941 | complexity and biological diversity that benefits Spotted Owl (see RA6)
- 5942 | 13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl
5943 | habitat) while allowing for other threats, such as wildfire and insects, to be addressed by
5944 | restoration management actions (see RA32).
- 5945 | 14. Conserve-Manage Northern Spotted Owl sites and high value habitat including the need to
5946 | maintain high habitat heterogeneity in some regions to provide additional demographic support
5947 | to population dynamics (see RA10).
- 5948 | 15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to
5949 | inform decisions concerning the possible development of habitat conservation networks in
5950 | California (see RA4).
- 5951 | 16. Assess habitat requirements for, and barriers to, dispersal in California through research on
5952 | Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and
5953 | availability, and habitat modeling.
- 5954 | 17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath
5955 | Province) to assist evaluating landscape-level issues in the Provinces in California, including
5956 | monitoring and adaptive management actions (see RA7 and RA9).
- 5957 | Wildfire
- 5958 | 18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).

Comment [LVD152]: 156.I think this could be combined with #9 to develop a monitoring program that gets estimates of demography rates in a few selected areas similar to what is currently being done on the 3 demographic study areas in CA, but then also add a methodology for getting statistically rigorous estimates of occupancy rates across the range.

Comment [LVD153]: 157.This can best be done on the demography study areas, which means they need a couple more strategically placed in other physiographic provinces. However, climatic parameters could be included in an occupancy analysis, which might actually be a better assessment of what is going on in the state.

Comment [LVD154]: 158.The implication here is to lock it up and don't do anything, but in some areas, the only way to get high quality habitat is to have mature stands in juxtaposition with young stands. This type habitat cannot be conserved, it has to be managed to insure adequate disturbance events to maintain the early seral forest stands.

Comment [LVD155]: 159.It is very expensive to try to keep track of dispersing juveniles with traditional telemetry and they don't have satellite radios that are small enough for NSO. I would consider this a pretty low priority given the extensive amount of habitat in CA.

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- 5959 19. Retain large, dense patches of forests embedded in a matrix with reduced stand densities to
5960 limit the potential for stand-replacement fire and competitive pressure on old trees.
- 5961 20. Conduct experiments to better understand how vegetation management treatments (e.g.,
5962 thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern
5963 Spotted Owl habitat, prey abundance and distribution, and demographic performance (see
5964 RA11).
- 5965 a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in
5966 use of burned areas for foraging warrants additional research on long-term use of
5967 burned areas post-fire.
- 5968 21. Gather information on the effect of historical fire suppression and current fire regimes on owl
5969 habitat, especially on the quality of habitat as assessed through demographic rates at individual
5970 owl territories.
- 5971 22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of
5972 Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.
- 5973 23. Develop a process for evaluating the likely effects of post-fire management activities, such as
5974 salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate
5975 this process into post-fire management decisions.
- 5976 24. Concentrate post-fire silvicultural activities on conserving and restoring habitat elements that
5977 take a long time to develop, such as large trees, medium and large snags, downed wood (see
5978 RA12).
- 5979 Barred Owl
- 5980 25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy,
5981 reproduction, ~~and~~ survival and population trends in California (see RA23).
- 5982 26. Promote experimental removal of Barred Owls within Northern Spotted Owl range, and if lethal
5983 removal is deemed a long-term management tool to manage negative effects of Barred Owls,
5984 explore methods for implementation within California (see RA22, RA29, and RA30).
- 5985 27. Investigate the potential for resource partitioning of Barred Owls and Northern Spotted Owls
5986 (see RA26).
- 5987 28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted
5988 Owl interactions.
- 5989 a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by
5990 the presence or absence of Barred Owls, but other unknown factors may also play a
5991 role.

Comment [LVD156]: 160. This management recommendation trumps all the others combined. It isn't going to matter in the slightest how much habitat we conserve, manage or develop if barred owls are allowed to increase as they have in the past and exclude NSO from all the habitat. Barred owls need to be thought of as a form of at least temporary habitat loss, which becomes permanent if no management actions are taken to reduce the barred owl population growth.

Comment [LVD157]: 161. This really needs to happen, but it would be a very complex, long term and expensive study to implement. I have thought a lot about this and it should be incorporated into the experimental design of at least a couple of the barred owl removal experiments.

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Disease and Contaminants

29. Monitor prevalence and extent of sudden oak death within the Northern Spotted Owl range in California, and address as appropriate (see RA17).

30. Investigate the potential influences of sudden oak death on Northern Spotted Owl habitat, occupancy, and prey species abundance over the short- and long-term.

31. Expand assessment of the impacts of marijuana cultivation (both illegal and legal) on the Northern Spotted Owl and their habitat.

a. The watersheds analyzed to date comprise only 4% of the Northern Spotted Owl range. Uncertainties in the dataset analyzed make it likely that the density of legal cultivation sites is higher than reported in the analysis. In addition, given the measured density of cultivation sites within Humboldt, Trinity and Mendocino counties potential impact of marijuana cultivation sites on spotted owl habitat should be evaluated further.

b. Impacts of illegal cultivation to Northern Spotted Owls (e.g., habitat loss, exposure to toxins such and rodenticides) are largely unknown. Recent studies on anticoagulant exposure in fisher suggests some unknown impact to the owl since prey-base is shared between the two species.

32. Monitor prevalence of avian diseases (e.g., West Nile Virus, avian flu, *Plasmodium* spp.) in the Northern Spotted Owl population, and address as appropriate (see RA17).

33. Investigate the extent of stress induced impacts on Northern Spotted Owl reproduction and survival due to recreational activities (e.g., hiking, off-road vehicular use).

Listing Recommendation

[TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]

Protection Afforded by Listing

The following is a discussion of potential protection that could be afforded to the Northern Spotted Owl in California if listed under CESA. While the protections identified in this section would help to ensure the future conservation of Northern Spotted Owls, there are protections now in place that would continue if the owl were not listed under CESA. These include current protections afforded under the Northern Spotted Owl federal status, protections afforded under the Forest Practice Rules, coverage of the owl under HCPs and NCCPs, current CEQA requirements, and existing laws and regulations that make it illegal under State law to take owls in California.

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6024 It is the policy of the Department to conserve, protect, restore and enhance any endangered or any
6025 threatened species and its habitat (Fish & G. Code, § 2052.). The conservation, protection, and
6026 enhancement of listed species and their habitat is of statewide concern (Fish & G. Code, § 2051(c)).
6027 CESA defines “take” as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture,
6028 or kill. (Id. , § 86). Any person violating the take prohibition would be punishable under State law. When
6029 take is authorized through an incidental take permit, the impacts of the take must be minimized and
6030 fully mitigated, among other requirements.

6031 Increased protection of Northern Spotted Owl following listing would occur with required public agency
6032 environmental review under CEQA. CEQA requires affected public agencies to analyze and disclose
6033 project-related environmental effects, including potentially significant impacts on endangered, rare, and
6034 threatened species. Where significant impacts are identified under CEQA, the Department expects
6035 project-specific required avoidance, minimization, and mitigation measures will also benefit the species.

6036 CEQA would require analysis of potential impacts to Northern Spotted Owl regardless of listing status
6037 under CESA. In common practice, potential impacts to listed species is examined more closely in CEQA
6038 documents than potential impacts to unlisted species. State listing, in this respect, and required
6039 consultation with the Department during state and local agency environmental review under CEQA, is
6040 also expected to benefit the species in terms of related impacts for individual projects that might
6041 otherwise occur absent listing.

6042 Without listing, Northern Spotted Owl take for research purposes is allowed via a Scientific Collecting
6043 Permit, and federal ESA 10a(1)(a). With listing, a state research Memoranda of Understanding (MOU)
6044 would also be required (Fish & G. Code, § 2081, subd. (a)). The added oversight allowed from MOU
6045 process is expected to benefit the species in terms of added coordination and research design, but will
6046 not likely add any additional protection.

6047 In listing the Northern Spotted Owl under CESA, the Department would expect an increased level of
6048 coordination among public agencies, such as USFS, CAL FIRE, and the USFWS, and with private timber
6049 companies, increased level of Department involvement in the THP review and approval process, more
6050 regular and thorough acquisition of data, and a reevaluation of current management practices for the
6051 species. In addition, if the Northern Spotted Owl is listed under CESA, the likelihood that land and
6052 resource management agencies will allocate funds towards protection and recovery actions may
6053 increase.

Economic Considerations

6054
6055
6056 The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).
6057

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Appendix 1. Forest Practice Rule definitions of silvicultural prescriptions.

The Forest Practice Rules differentiate silvicultural methods into four silvicultural categories. These silvicultural categories include even-aged management, uneven-aged management, intermediate treatments, and special prescriptions.

An Alternative silvicultural prescription can be included in a timber harvest plan when an alternative regeneration method or intermediate treatment is more effective or more feasible than any of the standard silvicultural methods.

Even-aged Management

Section 913.1 – Even-aged management are methods designed to replace a harvestable stand with well-spaced growing trees of commercial species.

Clearcutting

Section 913.1(b) – Clearcutting regeneration method involves the removal of a stand in one harvest.

Seed Tree

Section 913.1(c) – The seed tree regeneration method involves the removal of a stand in one harvest except for well distributed seed trees of desired species which are left singly or in groups to restock the harvested area.

Seed Tree Seed Step

Section 913.1(c)(1) – Seed Tree Seed Step: The seed tree seed step is the regeneration step and shall meet the following requirements:

- (A) Retention of at least the following basal area of seed trees per acre which are 18 inches dbh or greater:
 - 1. Fifteen square feet basal area on site I, II and III lands and
 - 2. Twelve square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

- (B) No point within the logged area shall be more than 150 feet from a seed tree.
- (C) Seed tree species and site preparation measures shall be specified in the plan by the RPF.
- (D) Seed trees shall be marked by or under the supervision of an RPF prior to felling operations.
- (E) If natural regeneration is inadequate within two years after the first August following completion of timber operations, seed trees may be harvested and artificial regeneration shall be used to meet the requirements of Section 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)].

Seed Tree Removal Step

Section 913.1(c)(2) – No more than 15 predominant trees per acre may be removed in the seed tree removal step. Not more than 50 sq. ft. of basal area of predominant trees per acre may be removed in the seed tree removal step. The seed tree removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)].

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Shelterwood

Section 913.1(d) – The shelterwood regeneration method reproduces a stand via a series of harvests (preparatory, seed, and removal). The preparatory step is utilized to improve the crown development, seed production capacity and wind firmness of designated seed trees. The seed step is utilized to promote natural reproduction from seed. The removal step is utilized when a fully stocked stand of reproduction has become established, and this step includes the removal of the protective overstory trees. The shelterwood regeneration method is normally utilized when some shade canopy is considered desirable for the establishment of regeneration.

Shelterwood Preparatory Step

Section 913.1(d)(1) – The shelterwood preparatory step shall meet the following minimum standards:

- (A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.
 - 1. Thirty square feet basal area on site I, II and III lands and
 - 2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

- (B) No point within the logged area shall be more than 100 ft. from a seed tree.
- (C) Seed tree species shall be specified in the plan by the RPF.
- (D) At least 125 sq. ft. of basal area per acre on Site I lands, and 75 sq. ft. of basal area per acre on Site II and III lands and 50 sq. ft. of basal area per acre on site IV and V lands shall be retained.
- (E) The minimum stocking standards of 14 CCR § 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)] shall be met immediately upon completion of operations.

Shelterwood Seed Step

Section 913.1(d)(2) – The shelterwood seed step is the regeneration step and shall meet the following standards:

- (A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.
 - 1. Thirty square feet basal area on site I, II and III lands and
 - 2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

- (B) No point within the logged area shall be more than 100 ft. from a seed tree.
- (C) Seed tree species and site preparation measures shall be specified in the plan by the RPF.
- (D) Seed trees shall be marked by or under the supervision of an RPF prior to felling operations.
- (E) If natural regeneration is inadequate within two years after the first August following completion of timber operations, seed trees may be harvested and artificial regeneration shall be used to meet the requirements of 14 CCR § 912.7(b)(1), [932.7(b)(1), 952.7(b)(1)].
- (F) In the absence of a Sustained Yield Plan, to maintain and improve tree species diversity, genetic material and seed production, trees of each native commercial species where present at the time of harvest shall be retained after harvest.

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These leave trees shall be representative of the best phenotypes available in the preharvest stand. The RPF may propose and the Director may agree to a species specific plan in the THP which protects existing regeneration or provides for regeneration in-lieu of retaining trees.

Shelterwood Removal Step [Coast only]

Section 933.1(d)(3) - The shelterwood removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 912.7(b)(1). Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used once in the life of the stand. Regeneration shall not be harvested during the shelterwood removal step unless the trees are dead, dying or diseased or substantially damaged by timber operations. The minimum stocking standards of Section 912.7(b)(1) shall be met immediately upon completion of operations. The size limitations, and separation (spacing) by logical logging unit requirements, of Section 913.1(a) are applicable unless the post-harvest stand, regardless of average diameter, meets the stocking standards of Section 913.3(a)(1)(A) or (B)]. Not more than 32 predominant trees per acre may be removed in the shelterwood removal step. Not more than 100 square feet of basal area of predominant trees per acre may be removed in the shelterwood removal step.

Shelterwood Removal Step [Northern and Southern]

The shelterwood removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 932.7(b)(1) [952.7(b)(1)]. Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used once in the life of the stand. Regeneration shall not be harvested during the shelterwood removal step unless the trees are dead, dying or diseased or substantially damaged by timber operations. The minimum stocking standards of Section 932.7(b)(1) [952.7(b)(1)] shall be met immediately upon completion of operations. If the extent and intensity of the ground disturbance caused by the harvest is essentially the same as would have been caused by a clearcut or will cause adverse cumulative effects on wildlife as determined by the RPF or Director, the size limitations, and separation (spacing) by logical logging unit requirements of Section 933.1(a) [953.1(a)] are applicable unless the post-harvest stand, regardless of average diameter, meets area stocking standards of Section 933.3(a)(1)(A) or (B) [953.3(a)(1)(A) or (B)].

Uneven-aged Management

Sections 895.1 and 4593.2(c) – Uneven-aged management means the management of a specific forest, with the goal of establishing a well-stocked stand of various age classes and which permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop. Also defined in the SAF Dictionary of Forestry as “a stand of trees of three or more distinct age classes, either intimately mixed or in small groups”.

Selection/Group Selection

Section 913.2(a) – Under the selection regeneration method, the trees are removed individually or in small groups sized from 0.25 to 2.5 acres.

Transition

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Section 913.2(b) – The transition method may be used to develop an unevenaged stand from a stand that currently has an unbalanced irregular or evenaged structure. The transition method involves the removal of trees individually or in small groups from irregular or evenaged stands to create a balanced stand structure and to obtain natural reproduction.

Intermediate Treatments

Section 895.1 – Intermediate treatments means harvests conducted to modify or guide the development of an existing stand of trees, but not to replace (regenerate) the stand with a new one. The treatments involve the removal of trees to allow expansion of the crowns and root systems.

Commercial Thinning

Section 913.3(a) – Commercial thinning is the removal of trees in a young-growth stand maintain or increase average stand diameter of the residual crop trees, promote timber growth and/or improve forest health.

Sanitation-Salvage

Section 913.3(b) – Sanitation is the removal of insect attacked or diseased trees in order to maintain or improve the health of the stand. Salvage is the removal of only those trees which are dead, dying, or deteriorating, because of damage from fire, wind, insects, disease, flood or other injurious agent.

Special Prescriptions

Section 913.4 – Special Prescriptions are special harvesting methods which are appropriate under certain conditions.

Special Treatment Area

Sections 895.1 – Special Treatment Areas are specific locations which contain one or more of the following significant resource features which may be at risk during timber operations:

- a. Within 200 feet of the watercourse transition line of federal or state designated wild and scenic rivers;
- b. Within 200 feet of national, state, regional, county or municipal park boundaries;
- c. Key habitat areas of federal or state designated threatened, rare or endangered species;
- d. Coastal Commission special treatment areas;
- e. Within 200 feet of state designated scenic highways or within scenic corridors established pursuant to Article 2.5 (commencing with Section 260) of Chapter 2 of Division 1 and Section 154 of Chap. 1 of Div. 1 of the Streets and Highways Code.

Section 913.4(a) – Special consideration in Special Treatment Areas shall be given to selection of a regeneration method or intermediate treatment compatible with the objectives for which the special area was established. Such areas shall be identified in the plan. To assure the integrity of legally designated historical and archaeological sites and legally designated ecological reserves, and that the objectives of the special treatment areas are met, the RPF and the Director may agree, after on-the-ground inspection, if requested by either party, on specific silvicultural and logging practices to protect such areas. The Director shall notify affected agencies or groups with expertise in the resource involved in the special treatment area of any such areas located during the THP review process.

Rehabilitation

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7037 Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial
7038 timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7)
7039 prior to any timber operations on such lands, an area may be harvested provided it is restocked
7040 in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be
7041 included in the THP. The regeneration plan shall include site preparation, method of
7042 regeneration, and other information appropriate to evaluate the plan.
7043
7044 Fuelbreak/Defensible Space
7045 Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a
7046 shaded fuel break or defensible space in an area to reduce the potential for wildfires and the
7047 damage they might cause.
7048
7049 Variable Retention
7050 Section 913.4(d) - Variable retention is an approach to harvesting based on the retention of
7051 structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for
7052 integration into the post-harvest stand to achieve various ecological, social and geomorphic
7053 objectives.
7054
7055 Conversion
7056 Section 1100 – within non-timberland production zone (TPZ) timberland, transforming
7057 timberland to a nontimber growing use through timber operations.
7058
7059 **Alternative Prescription**
7060 A written analysis of preharvest and postharvest timber stand conditions and a description of the
7061 silvicultural practices and systems to be used in lieu of the standard methods. An Alternative silvicultural
7062 prescription can be included in a timber harvest plan when an alternative regeneration method or
7063 intermediate treatment is more effective or more feasible than any of the standard silvicultural
7064 methods.
7065 Section 913.6 – When an Alternative method is used, the plan must include a statement of which
7066 silvicultural method in the current District rules is most nearly appropriate or feasible and an
7067 explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how
7068 the proposed alternative prescription will differ from the most nearly feasible method in terms of
7069 securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in
7070 terms of fire, insect and disease protection.
7071
7072 NonTimberland Area
7073 Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land,
7074 other than land owned by the federal government and land designated by the board as experimental
7075 forest land, which is available for, and capable of, growing a crop of trees of a commercial species used
7076 to produce lumber and other forest products, including Christmas trees.
7077
7078 Road Right of Way
7079 No strict definition
7080
7081
7082

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Appendix 2: Forest Practice Rule definitions regarding Northern Spotted Owl or their habitat

Activity Center (AC) means a known northern Spotted Owl site documented from detections, pursuant to the USFWS document “Protocol For Surveying Proposed Management Activities That May Impact Northern Spotted Owls” revised March 17, 1992.

(a) An AC is established by:

(1) Resident Single Status is established by:

(A) The presence or response of a single owl within the same general area on three or more occasions within a breeding season, with no response by an owl of the opposite sex after a complete survey;

(B) Multiple responses over several years (i.e., two responses in year one and one response in year 2, from the same general area).

(2) Pair Status Unknown is where the presence or response of two birds of the opposite sex is detected but pair status cannot be determined and where at least one member must meet the resident single requirements.

(3) Pair Status wherein a male and female are heard and/or observed (either initially or through their movement) in proximity (less than one-quarter mile apart) to each other on the same visit; or a male takes a mouse to a female; or a female is detected on the nest; or one or both adults are observed with young.

(4) Unoccupied Status where no responses have been obtained from a previously identified northern Spotted Owl activity center after 3 years of survey, barring other evidence to the contrary.

An AC with unoccupied status will not be considered an AC when it has been evaluated and a determination made by the Director. The determination shall be based upon available information on survey history, habitat conditions within the home range, and changes to habitat that may have occurred since the northern Spotted Owl site was first identified.

Functional Foraging Habitat is dependent upon the presence and availability of prey on the forest floor or in the canopy; presence of accessible perching limbs; and adjacency to stands with canopy closures >40%. Average stem diameter is usually >6" dbh for hardwoods and >11" dbh for conifers among dominants, and co-dominants, and the total overhead canopy closure, including intermediate trees is at least 40%. Where overall canopy closure is >80%, foraging habitat is limited to areas with ample flight space below limbs and among stems. Foraging habitat in smaller size classes and lower percentage canopy closures must be justified by local information.

Functional Nesting Habitat means habitat with a dominant and co-dominant tree canopy closure of at least 40% and a total canopy (including dominant, co-dominant, and intermediates) of at least 60%. Usually the stand is distinctly multi-layered with an average stem diameter in dominant, and co-dominant conifers, and hardwoods >11" dbh. The stand usually consists of several tree species (including hardwoods) of mixed sizes. All nests, snags, down logs, and decadent trees shall also be considered as part of the habitat. Nesting substrates are provided by broken tops, cavities, or platforms

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7122 such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are
7123 known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with
7124 characteristics of topographic relief and aspect which alter microclimates.

7125 **Functional Roosting Habitat** during the territorial breeding season, consists of stands where
7126 average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers
7127 provide an average of at least 40% canopy closure but the stand can have a high degree of variability.
7128 Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for
7129 protection from various environmental conditions, including wind, heat, and precipitation.

7130 **Owl Habitat** means Type A, B, or C owl habitat or those areas with functional foraging habitat,
7131 functional nesting habitat, and functional roosting habitat which support the owl's biological needs for
7132 breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the
7133 functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls
7134 are known to occasionally inhabit less than optimal forest structure, local information can be used to
7135 justify the modification of functional habitat definitions.

7136 **Type A Owl Habitat** means timber stands that have as a minimum the following characteristics for
7137 live-tree structure:

- 7138 **1. Canopy layers:** The stand has two distinct tiers or is multi-layered with dominant
7139 conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for
7140 some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.
7141 **2. Canopy Closure:** The canopy closure of conifers greater than 120 ft. tall (or greater than
7142 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
7143 and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.
7144 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than nine
7145 stems per acre and not less than six stems per acre and includes a component of trees with sparse,
7146 broken, or dead tops.
7147 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
7148 than 15 stems per acre and not less than 8 stems per acre.
7149 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
7150 than 50 stems per acre and not less than 20 stems per acre.
7151

7152 **Type B Owl Habitat** means timber stands that have as a minimum the following characteristics for
7153 live-tree structure:

- 7154 **1. Canopy Layers:** Moderately to strongly two-tiered or multi-layered with dominant
7155 conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some
7156 montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.
7157 **2. Canopy Closure:** The canopy closure of conifers greater than 100 ft. tall (or greater than
7158 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
7159 and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.
7160 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than six

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7161 stems per acre and not less than two stems per acre.

7162 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
7163 than 25 stems per acre and not less than 20 stems per acre.

7164 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
7165 than 50 stems per acre and not less than 20 stems per acre.

7166 **Type C Owl Habitat** means timber stands that have as a minimum the following characteristics for
7167 live-tree structure:

7168 **1. Canopy Layers:** Uniform to moderately layered with dominant conifers or hardwoods 50
7169 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.

7170 **2. Canopy Closure:** The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages
7171 greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is
7172 greater than 60%.

7173 **3. Large Trees:** The density of conifers greater than 35 inches dbh averages less than six
7174 stems per acre and may be absent.

7175 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
7176 than 15 stems per acre, but may be absent.

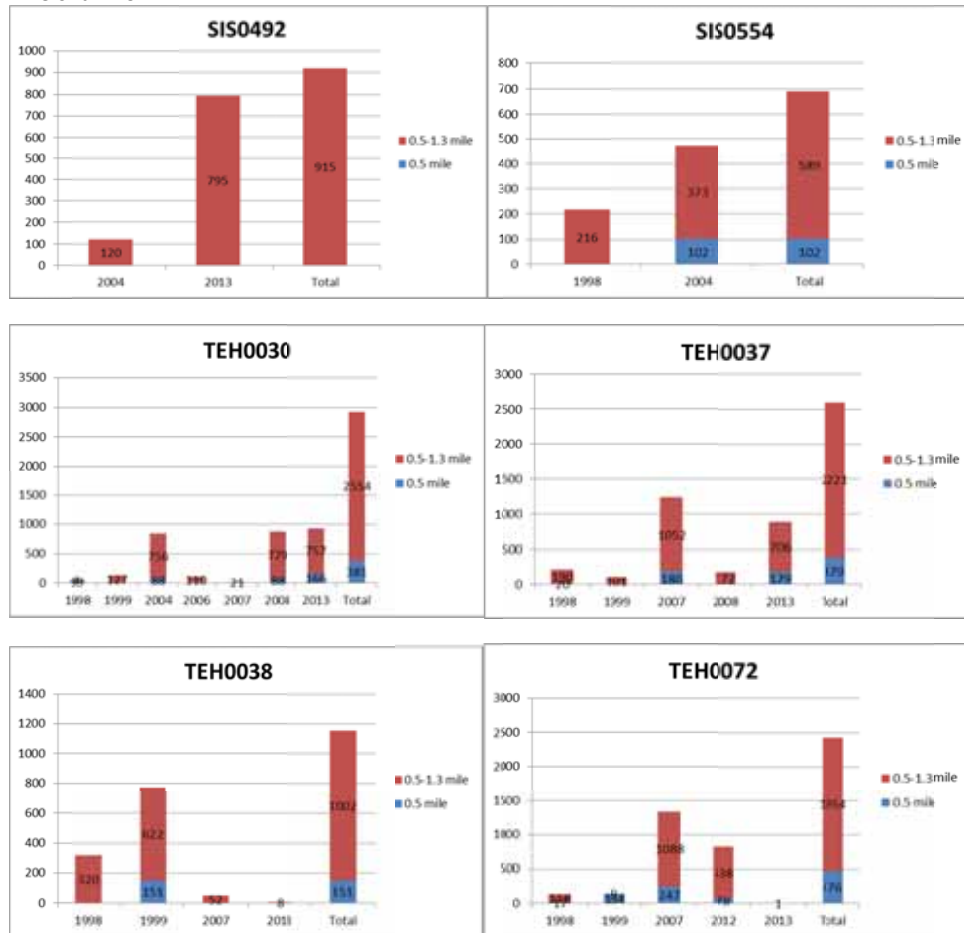
7177 **5. Small Trees:** The density of conifers or hardwoods less than 18 inches dbh averages
7178 more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the
7179 stand, including small, medium, and large trees is greater than 10 inches.

7180

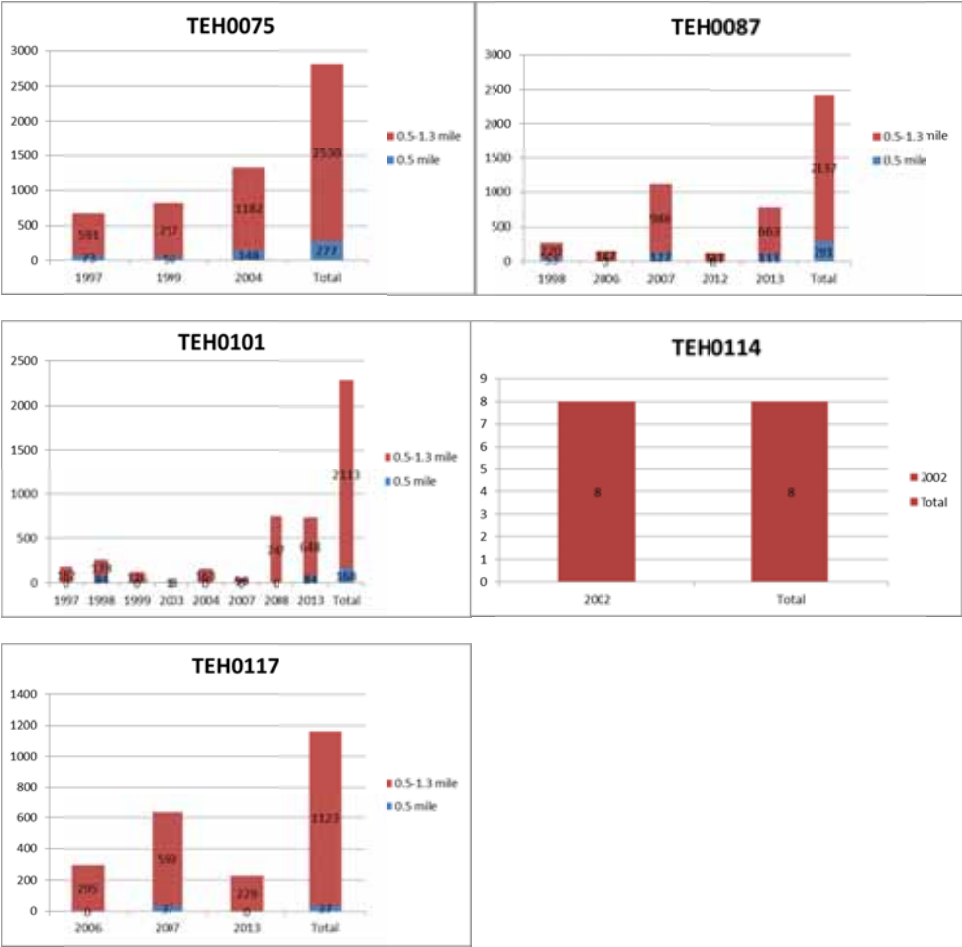
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Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

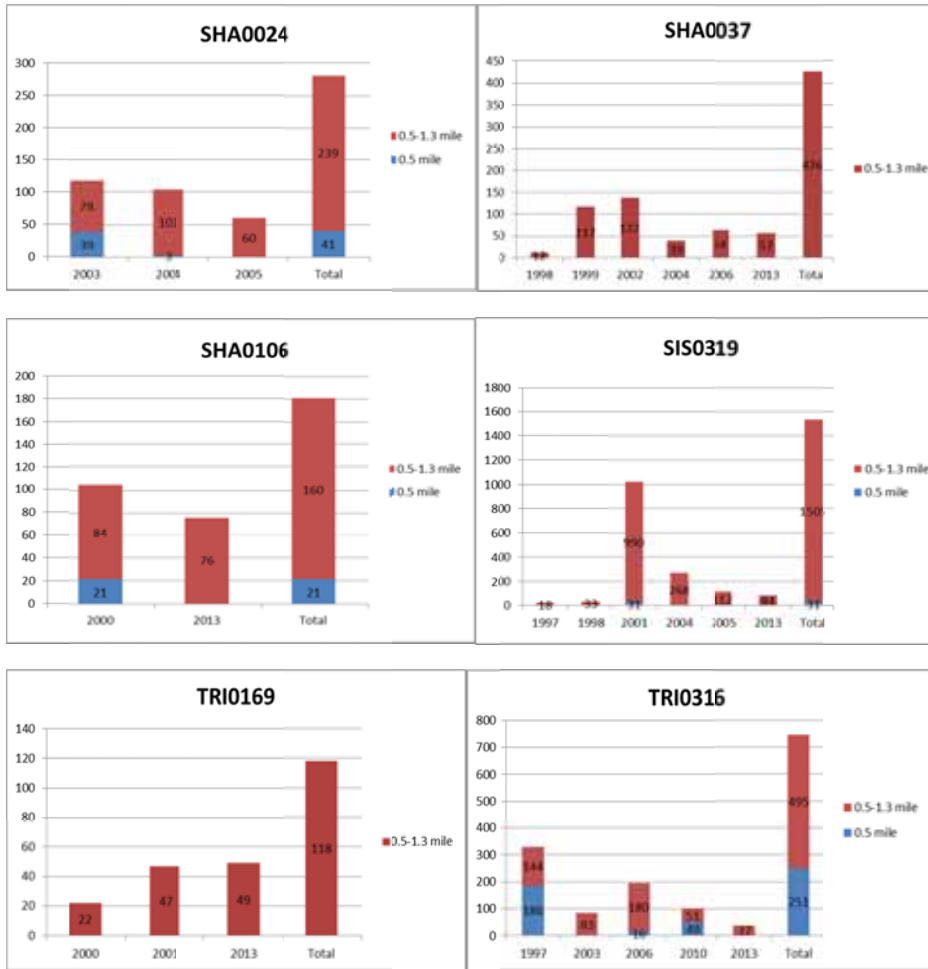


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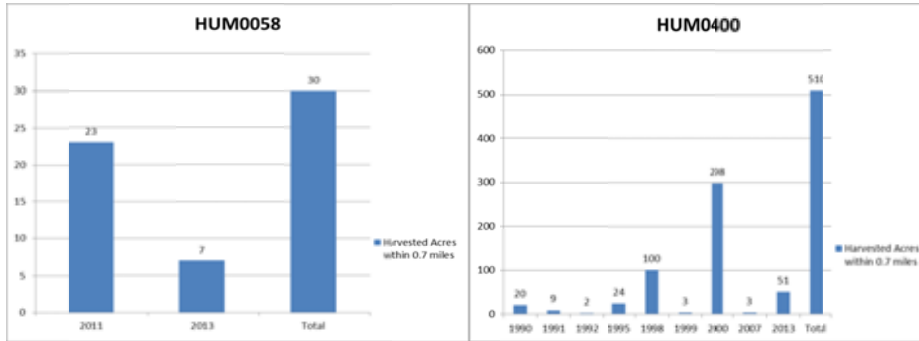
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7196 THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3
7197 mile of an AC

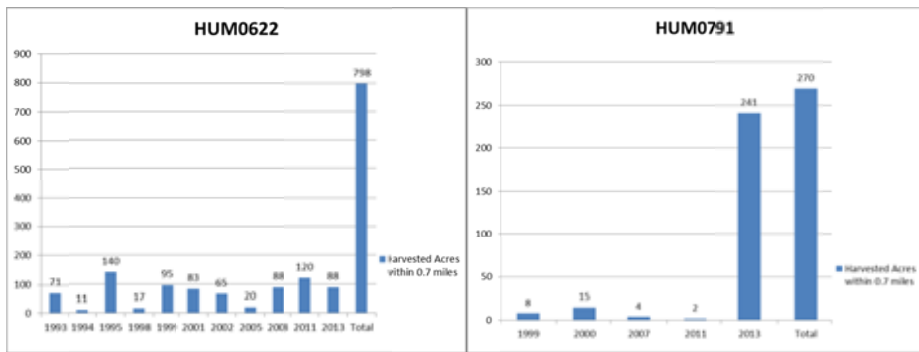


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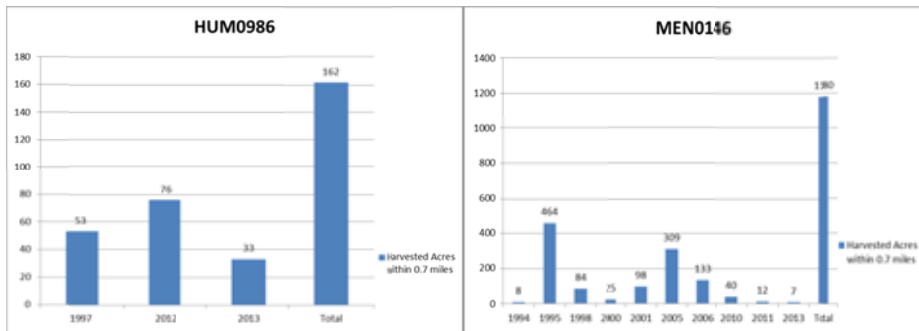
7202 THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



7203

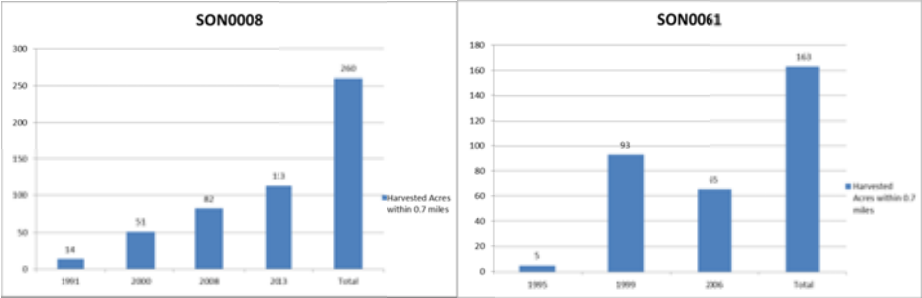
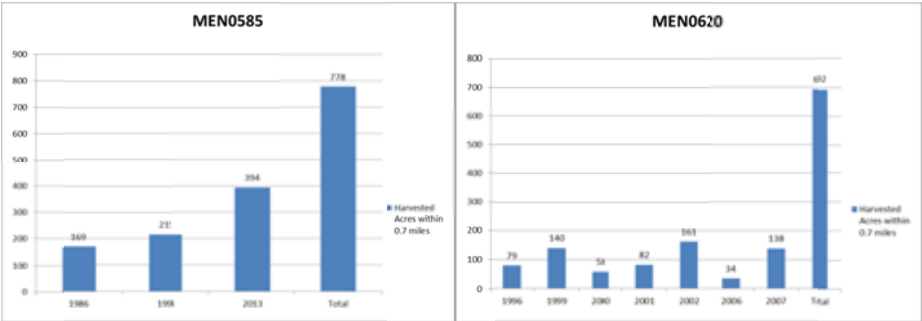
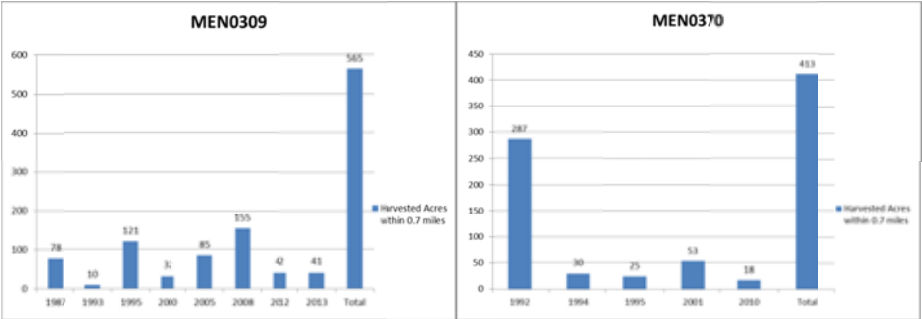


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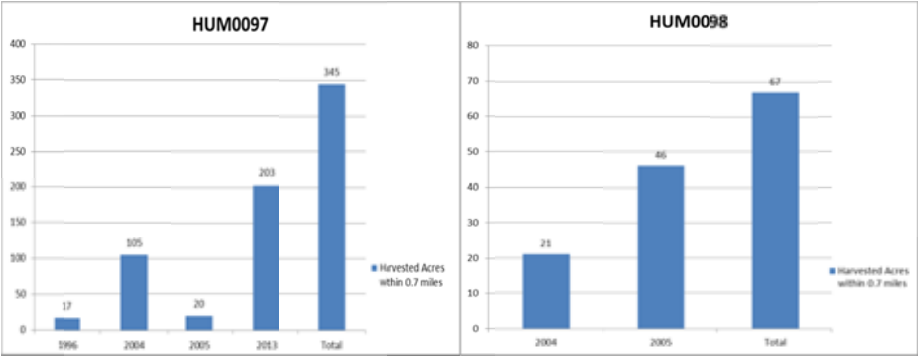
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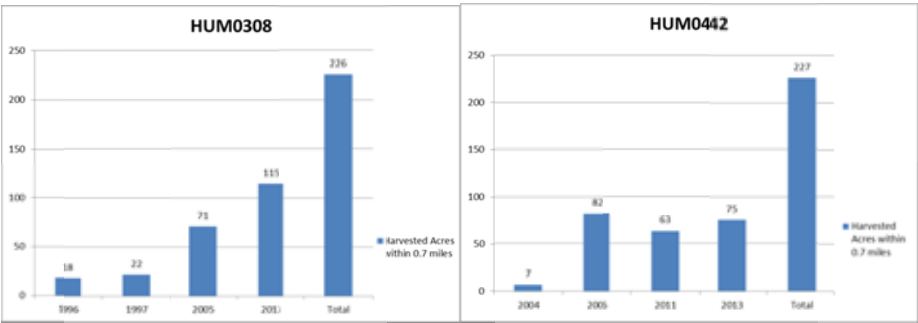


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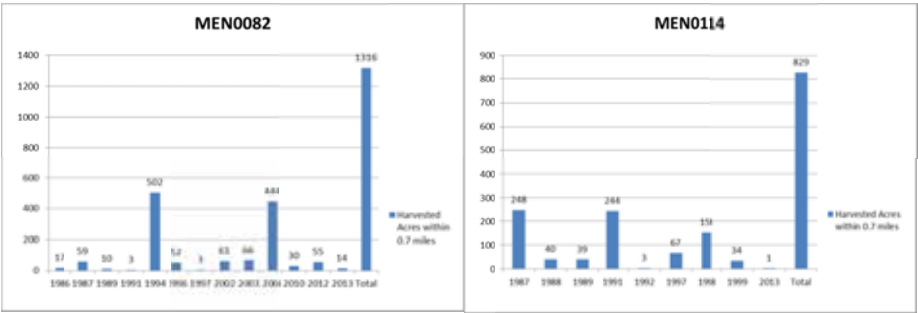
7210 THP’s utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



7212



7213



7213

7216

7215

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7216	Appendix 4. List of Acronyms and Abbreviations	
7217		
7218	AC	Activity Center
7219	AMA	Adaptive Management Areas
7220	AR	Anticoagulant Rodenticides
7221	BLM	Bureau of Land Management
7222	Board	Board of Forestry and Fire Protection
7223	BO	Biological Opinion
7224	BOE	Board of Equalization
7225	BOF	State Board of Forestry and Fire Protection
7226	CA State Parks	California Department of Parks and Recreation
7227	CAL FIRE	California Department of Forestry and Fire Protection
7228	Caltrans	California Department of Transportation
7229	CBD	Center for Biological Diversity
7230	CD	Consistency Determination
7231	CEQA	California Environmental Quality Act
7232	CESA	California Endangered Species Act
7233	CCAA	Candidate Conservation Agreement with Assurances
7234	CDFW	California Department of Fish and Wildlife
7235	CI	Confidence Interval
7236	CNDDDB	California Natural Diversity Database
7237	Commission	Fish and Game Commission
7238	CPV	Canine Parvovirus
7239	CSA	Conservation Support Areas
7240	CWHR	California Wildlife Habitat Relationships
7241	DBH	Diameter at Breast Height
7242	DSA	Density Study Area
7243	Department	California Department of Fish and Wildlife
7244	EIR	Environmental Impact Report
7245	EPA	Environmental Protection Agency
7246	ESA	Federal Endangered Species Act
7247	FEIS	Final Environmental Impact Statement
7248	FRGP	Fisheries Restoration Grant Program
7249	FGS	Fruit Growers Supply Company
7250	FEMAT	Forest Ecosystem Management Assessment Team
7251	FIA	Forest Inventory Analysis
7252	FMP	Forest Management Plan
7253	FPA	Forest Practice Act
7254	FRI	Fire Return Interval
7255	FSC	Forest Stewardship Council
7256	GDR	Green Diamond Resource Company study area
7257	GDRC	Green Diamond Resource Company
7258	ITP	Incidental Take Permit
7259	ITS	Incidental Take Statement
7260	JDSF	Jackson Demonstration State Forest
7261	HCP	Habitat Conservation Plan
7262	HFP	Habitat Fitness Potential

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7263	HCVF	High Conservation Value Forests
7264	HUP	Hoopa Indian Reservation study area
7265	HRC	Humboldt Redwood Company
7266	LSA	Late-Successional Areas
7267	LSAA	Lake or Streambed Alteration Agreement
7268	LSR	Late-Successional Reserve
7269	MBF	1,000 board-foot
7270	MIS	Management Indicator Species
7271	MMCA	Marbled Murrelet Conservation Areas
7272	MRC	Mendocino Redwood Company
7273	NCA	National Conservation Area
7274	NCCP	Natural Community Conservation Plan
7275	NIPF	Non-industrial private forest
7276	NPS	National Park Service
7277	NSO	Northern Spotted Owl
7278	NTMP	Nonindustrial Timber Management Plans
7279	NTO	Notice of Operations
7280	NWC	Northwest California study area
7281	NWFP	Northwest Forest Plan
7282	ORV	Off Road Vehicle
7283	PCB	Private Consulting Biologists
7284	PFT	Pacific Forest Trust
7285	PL	Pacific Lumber Company
7286	PRNS	Point Reyes National Seashore
7287	PSU	Primary Sampling Unit
7288	REF	Suppressed reproduction and growth
7289	RNSP	Redwood National and State Parks
7290	ROD	Record of Decision
7291	RPF	Registered Professional Foresters
7292	SEIS	Supplemental Environmental Impact Statement
7293	SHA	Safe Harbor Agreement
7294	SOMP	Spotted Owl Management Plans
7295	SOP	Spotted Owl Expert
7296	SORP	Spotted Owl Resource Plan
7297	SFI	Sustainable Forestry Initiative
7298	SP	State Park
7299	SPI	Sierra Pacific Industries
7300	TCP	Timberland Conservation Planning Program
7301	THP	Timber Harvest Plan
7302	TPZ	Timber Production Zone
7303	UCNRS	UC Natural Reserve System
7304	USFWS	U.S. Fish and Wildlife Service
7305	USFS	U.S. Forest Service
7306	USDA	United States Department of Agriculture
7307	USDI	United States Department of Interior
7308	USFS	United States Forest Service
7309	WCSA	Willow Creek Study Area
7310	WLPZ	Watercourse and Lake Protection Zones

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7311 WNV West Nile virus
7312

Page 15: [1] Comment [LVD14] **Lowell Diller** **9/24/2015 5:54:00 PM**

1. It is our experience that throughout incubation, females will come off the nest for 10-15 minutes to eat prey brought in by the male, defecate and preen. But the female relies completely on the male to be feed during incubation. I know Courtney et al. (2004) reported that the females forage on their own later in incubation based on Eric Forsman's work , but I wonder if that is an Oregon phenomenon where the primary prey is flying squirrels, which occur in much lower densities requiring females to do some foraging on their own. In our study area, woodrats are the primary prey and it seems like the females always have a cached woodrat nearby that the male has delivered. BTW, I also find it rather unlikely that precisely after 10 days of brooding the female starts foraging. Prey availability and weather (a female is not going to leave the nestlings during cold rainy weather) will have a big influence on how soon the female is going to start foraging on her own.

Page 15: [2] Comment [LVD15] **Lowell Diller** **9/25/2015 10:13:00 AM**

2. This contradicts the previous statement where the female starts making short foraging trips during incubation. None of this is critical information for the status review, but I would recommend combining these two sentences to say something like: *"During incubation and the early part of brooding, the male provides all the food to the nest with the female beginning to foraging as the nestlings develop and favorable weather conditions reduce the need for further brooding."*

Page 15: [3] Comment [LVD16] **Lowell Diller** **9/25/2015 11:06:00 AM**

3. I think it would be worth noting the owlets typically "fledge", which implies they are capable of flight, at a very premature stage when they are not truly flighted, but have to "limb hop" to move through the forest. At this stage, we have seen them fall and end up on or near the ground. In these cases, they climb back up the tree trunk like a parrot using their bill and feet.

Page 15: [4] Comment [LVD17] **Lowell Diller** **9/25/2015 11:15:00 AM**

4. That seems really late to being dispersing. Courtney et al. 2004 says that some juveniles begin to disperse in September and most have dispersed by early November. Our experience is that almost all of our fledglings disappear by September, although we didn't put radios on them to determine if they have actually dispersed or are just hunting in their natal territory.

Page 15: [5] Comment [LVD18] **Lowell Diller** **9/25/2015 11:53:00 AM**

5. Turnover at a site (i.e., one member of the pair is replaced by a new owl) has also been shown to negatively influence reproductive success (Thome et al. 2000 – Thome, Darrin M., Cynthia J. Zabel and Lowell V. Diller. 2000. Spotted owl turnover and reproduction in managed forest of north-coastal California. Journal of Field Ornithology 71(1):140-146.)

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
NORTHERN SPOTTED OWL
(*Strix occidentalis caurina*) IN CALIFORNIA

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Figure 1. The 12 physiographic provinces within the Northern Spotted Owl range.

Figure 2. The California Wildlife Habitat Relationship (CWHR) depiction of the Northern Spotted Owl and California Spotted Owl range.

Figure 3: Public Land Survey Sections containing Northern Spotted Owl activity centers in California documented within the Department's Spotted Owl Database, 1970-2014. A large portion of the increase in number of activity centers over time can be attributed to an increase in survey effort. A portion of the more recent activity centers may have resulted from new territories in areas of habitat recruitment; this is most likely in the coastal redwood portion of the range where forest growth is relatively fast and owls have been shown to use younger forests. Establishment of new activity centers may also represent displacement of owls from previously occupied habitat by Barred Owls or due to habitat loss. For these reasons, and the fact that the number of occupied activity centers in any given year is unknown, activity centers do not necessarily reflect current abundance or density.

Figure 4: Northern Spotted Owl habitat suitability map showing the spatial distribution of nesting/roosting habitat (adapted from Figure 3-9, Davis et al. 2011).

Figure 5: Northern Spotted Owl habitat suitability map showing the spatial distribution of dispersal habitat (adapted dispersal suitability model in Davis et al. 2011; Figure 3.7).

Figure 6: Modeling regions in California described in the 2011 Revised Recovery Plan for Northern Spotted Owls.

Figure 7: Locations of 11 Northern Spotted Owl demographic study areas used to assess vital rates and population trends.

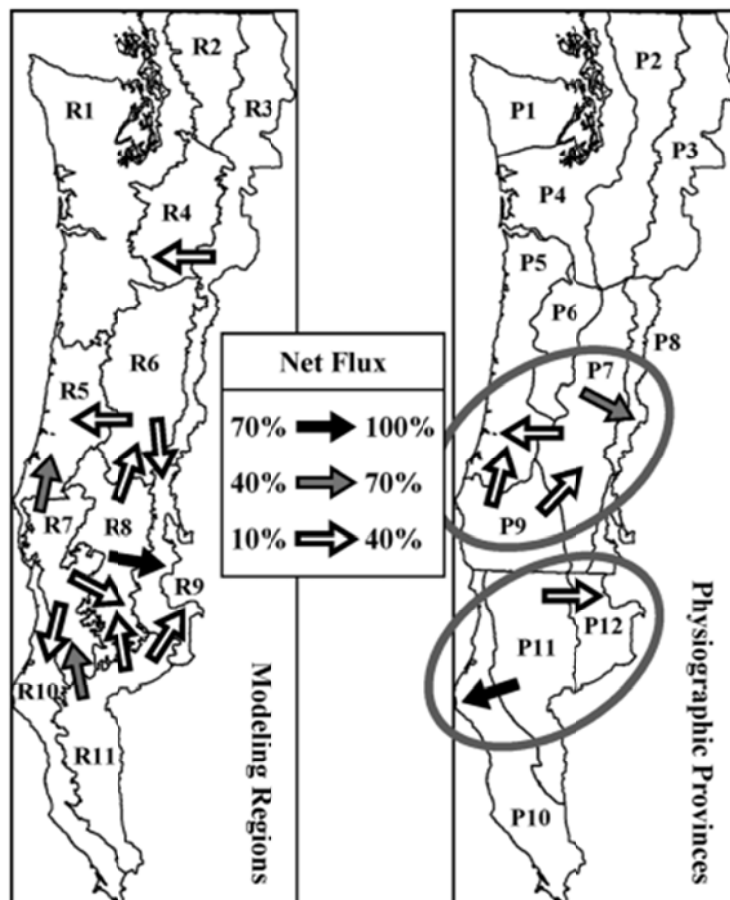


Figure 8. A graphical presentation of the net flux of Northern Spotted Owls between modeling regions and physiographic provinces (Schumaker et al. 2014, Table 3). Black, gray and white arrows indicate degree of flux, and arrows represent direction of flux. Gray ovals represent the two major patterns of NSO flux that emerged from the

physiographic provinces model simulations, patterns that are also evident in the modeling regions. R7 = Klamath West, R8= Klamath East, R9 = East Cascades South, R10 = Redwood Coast, R11 = Inner California Coast, P10 = California Coast, P11 = California Klamath, and P12 = California Cascades. I recommend deleting this figure. It creates the illusion of real NSO movements rather than the hypothetical movement of simulated owls in the hyperspace of a computer model.

Figure 9: Land Ownership within the Northern Spotted Owl Range Land ownership within the Northern Spotted Owl range in California.

Figure 10: Critical Habitat designation for Northern Spotted Owl in California.

Figure 11: Northwest Forest Plan land use allocation within the Northern Spotted Owl range in California.

Figure 12: Number and percent of Timber Harvest Plans submitted in Shasta, Siskiyou, Tehama, and Trinity counties (interior) during 2013 that were associated with Northern Spotted Owl activity centers of the Northern Spotted Owl range in California.

Figure 13: Number and percent of Timber Harvest Plans submitted in the Humboldt, Mendocino, and Sonoma counties (coastal) during 2013 that were associated with Northern Spotted Owl activity centers of the Northern Spotted Owl range in California.

Figure 14: Acreages of silvicultural prescription methods proposed for the 66 THPs utilizing Option (e) and associated with Northern Spotted Owl activity centers, submitted in 2013.

Figure 15: Acreages of silvicultural prescription methods proposed for the 9 THPs utilizing Option (g), and associated with Northern Spotted Owl activity centers, in 2013. What is the timeframe for the habitat loss?

Figure 16: Causes of nesting/roosting habitat loss on federally administered lands rangewide (Figure 3-11, Davis et al. 2011).

109
110 **Figure 17:** Changes in dispersal-capable landscapes across the Northern Spotted Owl’s range (Figure 3-17, Davis et
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Figure 20. Area in Humboldt County where marijuana cultivation sites overlap the home range for several activity centers.

Figure 21. Forest vegetation disturbances within the Northern Spotted Owl range from 1994-2007 (Figure 3-4, Davis et al. 2011).

Figure 22. Map (a) shows fire suitability modeling results within the Northern Spotted Owl range (Davis et al. 2011). Map (b) shows actual fires history during 1950-2013.

Figure 23. Annual burned area between 1628-1995 in the Hayfork Study Area, Shasta-Trinity National Forest, California. (Figure 2 in Taylor and Skinner 2003).

Figure 24. Frequency histogram of acres burned by wildfires within the range of the Northern Spotted Owl between 1970 and 2009 (Figure 4-2, Davis et al. 2011).

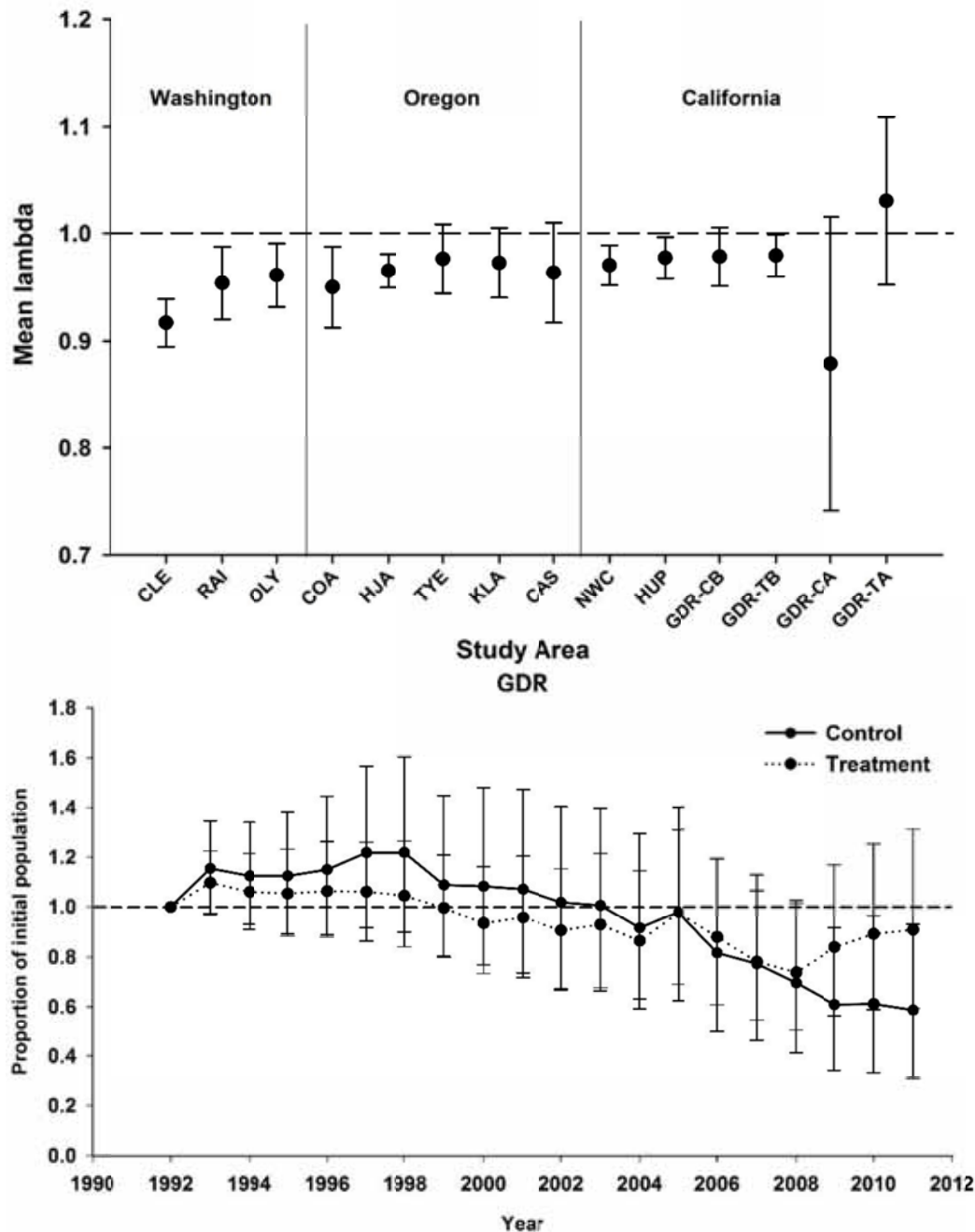
Figure 25. Percent change in precipitation within the Northern Spotted Owl range in California. Maps show both 30 year & 5 year averages

Figure 26. Percent change in maximum summer temperature within the Northern Spotted Owl range in California. Maps show both 30 year and 5 year average in June, July, and August.

Figure 27. Percent change in minimum winter temperature within the Northern Spotted Owl range in California. Maps show both 30 year and 5 year average in December, January, and February.

Figure 28. Range expansion of the Barred Owl, with selected arrival dates. Shaded area is an estimate of the expanded range of the Barred Owl in 2008 (from Livezey 2009a, Figure 2).

Figure 29. Barred Owl detections in California documented within the Department's Barred Owl Database, from 1978 to 2014, overlaid on the range of the Spotted Owl in California. A portion of the increase in number of detections over time can be attributed to an increase in survey effort. Detections do not necessarily reflect current abundance or density.



Potential new Figure 30. I think it would be useful to include both of these figures from Dugger et al. (In press). The upper graph indicates that the only potential bright spot for NSO throughout its entire range is on Green Diamond's treatment area where lambda increased >1.0. The lower graph shows the immediate population response to barred owl removal.

October 6, 2015

Dr. Eric Loft

Chief Wildlife Branch
California Department of Fish and Wildlife
1416 Ninth Street
Sacramento, CA 95814

RE: REPORT TO THE FISH AND GAME COMMISSION A STATUS REVIEW
OF THE NORTHERN SPOTTED OWL (*Strix occidentalis caurina*) IN
CALIFORNIA

Dear Eric:

I would like to begin by thanking the California Department of Fish and Wildlife for the opportunity to review the draft Status Review of the Northern Spotted Owl in California. The species has been the focal species of my professional career for over 20 years and it is very important to me both personally and professionally to make a contribution towards the conservation of spotted owls. Now in partial retirement, I will offer to assist the Department in any way I can to promote the recovery of this species that is not only one of the primary icons for conservation in the Northwest, but in my opinion, also represents one of the best opportunities to develop collaborative partnerships between multiple stakeholder groups in the conservation of a listed species.

Although my comments only reflect my personal views and conclusions, they have largely developed from field experience and data collected while working as an employee for Green Diamond Resource Company. Interactions with other spotted owl researchers and reading the scientific literature has also been instrumental in shaping my knowledge and views of spotted owl ecology.

Respectfully submitted,



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General comments: I can barely imagine the incredible task it must have been to assemble, review and synthesize the massive amount of information there is on northern spotted owls and their habitat. I think the Department and all the staff involved should be commended for doing a great job. It is my opinion that the Department has been very thorough in the review of the available literature on NSO and I only recommended adding 4-5 additional references. In general, I think the conclusions in the status review are based on a reasoned approach and the best available science, but my interpretation of a few selected sources of information differed from the Department's. The document is well written for an initial draft, and I only found a few areas where I felt some reorganization was warranted to produce a more logical flow of concepts and ideas. In addition to suggested changes recorded in Track Changes throughout the attached document, I have provided some general comments and discussions below for the Department to consider incorporating at some level in the final NSO status review.

Northern Spotted Owl Habitat Dynamics

My comments throughout the NSO status review reflect these same thoughts, but there are two habitat issues that I would like develop in more detail. These concepts apply directly to at least a substantial portion of the NSO range in California, maybe to a lesser degree, all NSO habitat in California. The issue is related to NSO habitat dynamics at two spatial scales and include: 1) NSO habitat is dynamic at the landscape scale and regrowth of even high quality nesting habitat can happen within decades, and 2) NSO habitat is even more dynamic at the home range scale and it cannot be preserved in a static state, but requires frequent stand-replacing disturbance events to maintain habitat heterogeneity.

Landscape NSO Habitat Dynamics:

The description and analysis of impacts to habitat in the draft status review, although very thorough based on the bulk of the published data and reports, need to include a more complete perspective on habitat dynamics at the landscape scale for substantial portions of California. The current amount of habitat and the factors that will tend to effect or reduce habitat quantity or quality are thoroughly explored, but there is no attempt to quantify or evaluate habitat recovery or regrowth. The whole concept is basically dismissed with a statement that timber growth is slow, so consequently, regrowth of owl habitat is slow. In my opinion that provides no useful information on habitat dynamics, because one could say that loss of habitat has also been slow in recent years. In some of the northern portions of the NSO range in Oregon and Washington, habitat regrowth may not represent much potential in the timeframe of most conservation planning (i.e., decades), but here in California, we have NSO living in the youngest forests anywhere in the species' range and substantial amounts of regrowth can occur in a matter of decades.

One problem with doing such an analysis is that there are no existing formal analyses of regrowth potential available similar to habitat loss assessments. All of the habitat assessments conducted by the Fish and Wildlife Service have also focused on just one side of the dynamic habitat issue. As a result, it may not be possible to provide precise estimates for different portions of the NSO range in California, but at least rough estimates in terms of decades are possible. Probably the best source of coarse estimates of regrowth rates can be obtained by evaluating the history of NSO habitat in various regions of the state. The basic concept would be to look at where NSO are currently occupying managed landscapes and assess the timeframe and factors associated with the historical liquidation of the habitat followed by its regrowth and reoccupation by NSO.

I am most familiar with this issue on the north coast of California, where regrowth of habitat is probably the most rapid anywhere in the owl's range. However, a historical review can provide useful insights relative to the habitat needs, ecology of NSO and what factors are most critical in accelerating regrowth potential anywhere in California. The historical logging of any region was the equivalent of a large crude "field experiment", which provided insights into the dynamics of NSO habitat and the ability of the species to adapt to a catastrophic human disturbance event.

NSO's living outside old growth is not a rare exception in California, and based on comparing Figure 3 and 9 of the California draft NSO status review, it may be the majority of known NSO sites. Obviously, there is a major bias in recent years with more survey effort on private timberlands, but the fact remains that there are a lot of NSO living on landscapes that had an extensive history of timber harvest. Getting a perspective on when and how the NSO habitat was initially liquidated could be challenging in some areas, but the photographs archived in the University of Berkeley Fritz-Metcalf collection provide a glimpse of the early logging practices in much of the state. I have used this photographic collection to gain insight on the early logging in the California Coast Province (see pictures below). It is also a region that was subjected to some of the most intensive logging activities anywhere in the range of the NSO in California.



Historical logging of the coastal old growth forests began in the late 1800's, but it was with cross-cuts and horse and oxen, which was a slow process and relatively little NSO habitat was likely impacted. The liquidation of habitat started to accelerate when steam donkeys and railroad logging began around the turn of the century, but the rapid liquidation of the old growth forests began after World War II with modern equipment and reached its peak in the 1970's. The picture on the left above was taken in the 1920's near Arcata, CA in the Fickle Hill area and the one on the right was a 1950 photograph of timber harvesting steadily progressing up the North Fork Mad River. These are both areas that had been re-colonized by substantial numbers of NSO sites when the first NSO surveys were conducted on Green Diamond's ownership in 1989. There are many more photographs that I have viewed from this early logging area, and what stands out is that this early logging looked extremely devastating by modern standards and often extended 1,000's of acres over entire basins or small watersheds. However, there was often substantial amounts of downed large wood and scattered residual trees left behind. This suggests that regrowth of owl habitat on the coast following total liquidation of all habitat in whole basins required a minimum of 40-70 years assuming there was retention of at least scattered residual structure.

Second growth harvesting of these same regions generally began in the 1980's and currently many of the watersheds in this region now have substantial amounts of third growth forests. The harvesting practices in the 1980's can be seen in the photograph of the lower Mad River in 1990. Clearcuts averaged about 60 acres during that period and retention of residual structure was quite minimal by current standards. As can be seen below in the Department's graph of historical timber harvesting levels, the 1980's were also a period of high levels of timber harvesting relative to more recent decades.



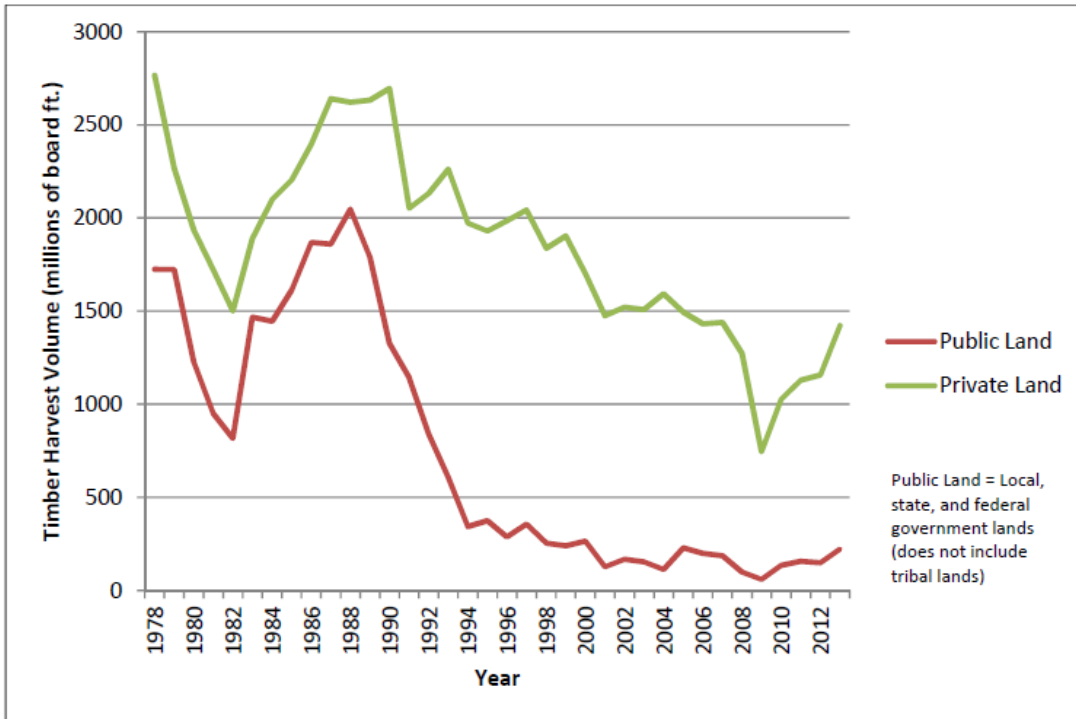


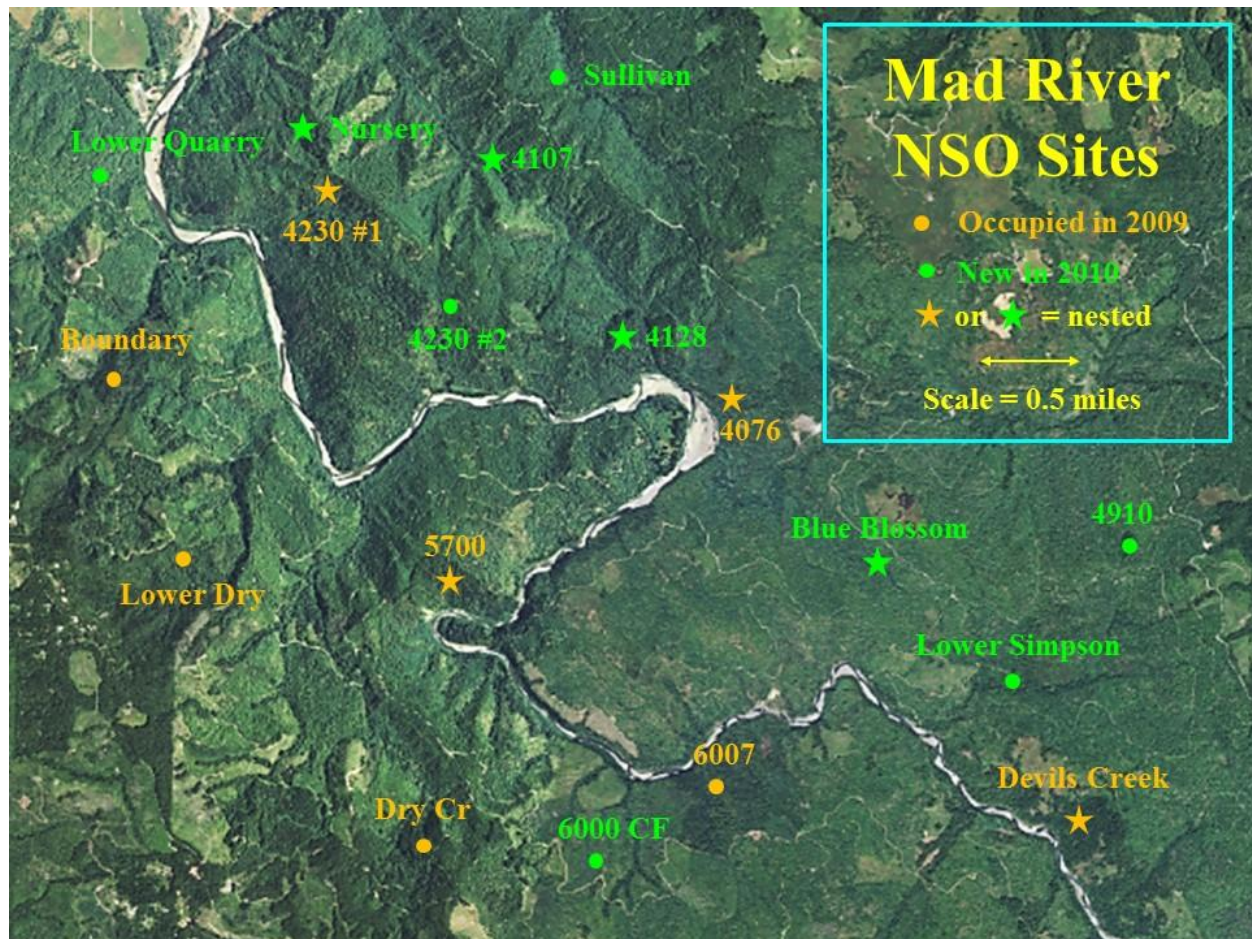
Figure 15. Volume of timber harvested on public and private lands in California (1978-2013) (California Timber Harvest Statistics n.d.).

Figure copied from the California Department of Fish and Wildlife fisher status review.

Using the lower Mad River as an example, the extensive timber harvest of the second growth forests started in 1979 and was essentially completed by 2000. We do not know what the NSO population may have been before the initiation of the second growth harvest, but the rapid and intensive harvesting resulted in only 10-15 NSO sites from 1992-2008. In 2010, there was a large jump in the number of known NSO sites when Green Diamond first started to survey the 25-30 year old third growth stands. This resulted in an increase to a total of 26 NSO sites in the Lower Mad River Tract of approximately 22,000 acres (a high population density for NSO), and these NSO sites also supported some of the highest successful nesting within Green Diamond's ownership at the time (see GDRC 22nd Annual Report and Figure below illustrates where most of the sites were recolonized). Recovery of NSO habitat sufficient to support nesting pairs of owls following harvesting of the second growth only required approximately 30 years. Presumably, it required less time for recovery of the second growth harvesting, because not all habitat was liquidated within a watershed; there were 9 set-aside areas averaging approximately 60 acres each that served as core roosting/nesting areas for some of the new NSO sites. The remaining new owl sites were located in retained riparian areas or habitat retention areas as provided by Green Diamond's NSO HCP. It is also very important to note that the Mad River was in one of Green Diamond's barred owl removal areas and this region was maintained free of

barred owls during the recolonization phase. The habitat potential of the area would never have been realized if barred owls would have been allowed to colonize all of the best core habitat areas as they have been demonstrated to do throughout the NSO range.

The Lower Mad River may represent one of the most extreme examples in California, but basically this can be viewed as a crude “field experiment” indicating that approximately 90% of a basin can be harvested as long as riparian and other habitat areas are retained and NSO will recolonize the area in approximately 30 years. I would expect similar rapid results in most of the redwood region, but presumably the recovery period would be slower in areas where stand development occurs at a slower pace. However, similar patterns of NSO habitat dynamics can be expected everywhere in the state where NSO have been able to recolonize managed timberlands following liquidation of the old growth forests. I have provided a rather crude example of how habitat recovery rates might be estimated, but even crude estimates would be useful in evaluating the habitat loss versus regrowth dynamic.



NSO Habitat Dynamics at the Home Range Scale:

As seen in the Franklin et al. (2000) monograph and the Green Diamond 10-year HCP review (Diller et al. 2010), the habitat that confers the greatest fitness potential (i.e., integration of the highest survival and fecundity potential) for NSO in northern California consists of a mosaic of older and younger stands with a high degree of edge. The concept is very simple; the owls roost and nest in the older more structurally complex stands and their primary prey (dusky-footed woodrats) thrive in young brush/sapling stage stands, so home ranges with lots of edge between these two basic habitat types maximizes the potential to meet all of the owl's needs to survive and reproduce.

It was viewed as almost sacrilege when the Franklin monograph first documented that too much old growth in an owl's home range was equally detrimental as too much "other habitat" (i.e., early seral stands and brush or hardwood areas maintained by edaphic or topographic factors). While most biologists accept that habitat heterogeneity may be beneficial to NSO in some regions, what is often missed in the assessment of NSO habitat, is not only is the habitat dynamic, but in those portions of the NSO range where owls depend heavily on dusky-footed woodrats as prey, this means habitat cannot be "preserved." Without continued disturbance, habitat heterogeneity will be lost and habitat fitness will decline to create sink habitat (habitat fitness <1.0). The poorest quality habitat is at either extreme when there is either too much or too little late seral or old growth habitat. This indicates that habitat can and will be lost due too complete protection from disturbance just as likely as too much disturbance. In other words, part of the assessment of potential habitat loss should include an evaluation of areas likely to exclude both natural and human-caused disturbance such that habitat heterogeneity will decline and habitat quality will decline. I have never seen this type of analysis even though it has strong support from several long term demographic studies and it is completely logical from an ecological perspective.

I say this only partly "tongue in cheek", but when you look at the trend in timber harvesting in the figure above, it is "interesting" that NSO numbers seem to be tracking trends in timber harvesting. When I first started working on NSO in the early 1990's in the coastal redwood region, the 60 acre clearcuts of that time that were typically also treated with broadcast burns had very high densities of dusky-footed woodrats (Hamm 1995) and Green Diamond's owl population was increasing or stable during the 1990's (Dugger et al. In press). We know that barred owls have been a major driver of the NSO decline, but we have had poor fecundity in recent years throughout the entire coastal region, which could be influenced by a declining prey base. Clearcuts of the 1980's and early 1990's era were not pretty by most human standards, but woodrats and other early seral species thrived in them. I continue to wonder if the recent trend of lighter-touch forestry may actually be having some unintended negative consequences for NSO by creating unfavorable conditions for woodrats. Forest land managers on the coast are either going to even aged management with small clearcuts (opening size on Green Diamond's harvest units now average under 20 acres) or some form of uneven

aged management. From a woodrats perspective that means that habitat patches have become very small and are essentially all edge. This might be good from a NSO's perspective, but it could mean that these early seral patches are now too small to provide for sustainable populations of woodrats. Basically, I am concerned that modern forestry practices are creating marginal or sink habitat for dusky-footed woodrats, which is maintaining their population at much lower levels than the "hay days" in the 1990's when we were documenting high NSO population densities and fecundity in coastal forests. Green Diamond monitored woodrat numbers throughout its ownership from 2004-2014 and documented a general downward trend over the decade. There are a variety of factors such as climate change that could also contribute to the trend, but I strongly suspect that silvicultural changes are at least one of the major contributing factors.

The presumption has always been that some sort of uneven aged management is better for NSO, because it results in the loss of fewer trees per acre. The impact of such harvesting is undoubtedly less when attempting to minimize short term impacts to nesting and roosting habitat, but the impacts are potentially greater when such harvesting practices are applied at a landscape scale. Based on any studies of which I am aware, it is a totally untested hypothesis that widespread uneven aged management at the landscape scale will work for NSO. There are no data available from a demographic study to show that this will actually work for NSO. To my knowledge, the only studies documenting long term persistence of NSO on managed timberlands (e.g., Green Diamond, Hoopa, HRC and MRC) have been on landscapes created primarily by even aged management. Several timber companies are proposing in HCPs to move towards landscape level uneven aged management, but I predict it will be unsuccessful due to a gradual degradation of woodrat habitat. The only data we have available from the redwood region suggests that uneven aged management would be detrimental to maintaining woodrat populations and therefore, habitat heterogeneity (Hamm and Diller 2009). I find it very disturbing that we are not attempting to learn from the historical "big experiment", which showed that creating large stands full of woodrats seemed to work quite well for NSO. Until we have long term studies indicating otherwise, it would seem prudent to replicate what has worked for NSO in the past; create openings large enough to support healthy populations of woodrats while retaining and recruiting substantial amounts of residual late seral structure and downed wood.

Barred Owls

The treatment of the barred owl threat is covered well in the status review, but I think there needs to be greater emphasis on the growing consensus relative to this threat. In short, all of the discussions and assessments of habitat losses (or gains) are totally irrelevant if the barred owl threat is not addressed. Barred owls are excluding NSO from the best habitat and this effective habitat loss completely trumps every other threat. We agonize over potential losses of a few percent due to harvest or wildfire when barred owls have displaced NSO from the majority of the habitat in many portions of its range.

For example, think about how much habitat was effectively lost to NSO when barred owls took over Redwood National and State Parks. Barred owls may still be in relatively low numbers in much of California, but what happened in RNSP is being replicated in other areas across the state, and all the data to date indicate that it is just a matter of time before barred owls dominate the entire landscape. The bottom line is that if steps are not taken to address this primary threat, nothing else that might be done for NSO will matter. With the lower numbers of barred owls in many areas, California is in a position where it could be much easier to manage the threat, but this will take prompt and decisive action by the state.

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Comments from Katie Dugger, Ph.D.

From: [Dugger, Katie](#)
To: [Clipperton, Neil@Wildlife](#)
Cc: [Battistone, Carie@Wildlife](#)
Subject: NSO status review
Date: Tuesday, October 06, 2015 12:45:32 PM
Attachments: [NSO SR external peer review Final 8Sept2015 KMD.docx](#)

Dear Neil (and Carie),

Please find attached my review of your draft status report for NSO in California. This is an impressive effort as I know how much information there is on the spotted owl (all 3 subspecies) and also how much we still don't understand. I conducted my review using track changes, and you'll see both editorial comments (which I can't help these days given all the editing I do....ignore word-smithing, etc., as you see fit) as well as specific comments on interpretation, etc.. When my editing changed the interpretation of the information you were providing I tried to explain my reasoning in the comments and the editing is just an example of how I would attempt to convey the information in question.

In general, I think you did a great job exploring the available literature, but there is so much to digest, and in some cases so much detail provided with entire paragraph(s) dedicated to summarizing a single study, that I think the take-home message gets lost, or in some cases is just unclear. I tried to highlight areas where this was a particular problem and you'll see suggestions that you "synthesize and condense" the information presented. So what I mean is that rather than exploring each piece of key research in great detail, summarize all the relevant research into a few key take-home points and general conclusions, so that you leave the reader "knowing" what all the current science collectively says about a topic (or at least what you think it says). Since all the relevant citations are included, the study detail can be explored by the reader if they are so inclined. I think this sort of revision would greatly reduce redundancy and the overall size of the document, while focusing the reader on the important conclusions that you'll be using to decide whether NSO should be listed or not.

Hope this helps and as I said, I'd be happy to review the demographic section again after you've had a chance to incorporate the new meta-analysis results.

Best regards,
Katie

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STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
NORTHERN SPOTTED OWL
(*Strix occidentalis caurina*) IN CALIFORNIA



CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
EXTERNAL REVIEW DRAFT, September 8, 2015



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Comment [A1]: Note to external reviewers:
These appendices will be added later.

Acknowledgments (to be completed after external review)

This report was prepared by: Neil Clipperton and Carie Battistone

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**Report to the Fish and Game Commission
A Status Review of the Northern Spotted Owl in California
EXTERNAL REVIEW DRAFT, September 8, 2015**

Executive Summary

[TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]

Regulatory Framework

Petition Evaluation Process

A petition to list the Northern Spotted Owl as threatened or endangered under the California Endangered Species Act (CESA) was submitted to the Fish and Game Commission (Commission) on September 7, 2012 by the Environmental Protection Information Center. A petition evaluation report was prepared by the Department of Fish and Wildlife (Department) and submitted on February 14, 2013, to assist the Commission in making a determination as to whether the petitioned action may be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & (e)).

The Department's charge and focus in its advisory capacity to the Commission is scientific. A petition to list or delist a species under CESA must include "information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The Petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and other factors the Petitioner deems relevant" (Fish & G. Code, § 2072.3). Given this charge the Department recommended to the Commission that the petition be accepted.

Status Review Overview

The Commission published findings of its decision to advance the species to candidacy on December 27, 2013, triggering a 12-month period during which the Department conducted a status review to inform the Commission's decision on whether to list the species. Per Fish & G. Code, section 2074.6, the Department requested a 6-month extension, to allow further analysis and evaluation of the available science, completion of the status review, and peer review process. Due to the extension, Department had a total of 18 months from December 27, 2013 to deliver the status review to the Commission.

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269 This written status review report indicates, based upon the best scientific information available,
270 whether the petitioned action is warranted, preliminary identification of ~~es~~-habitat that may be essential
271 to the continued existence of the species, and recommends management activities and other
272 ~~recommendations-activities~~ for recovery of the species (Fish & G. Code, § 2074.6). Receipt of this report
273 is to be placed on the agenda for the next available meeting of the Commission after delivery. At that
274 time, the report will be made available to the public for a 30-day public comment period prior to the
275 Commission taking any action on the Department’s recommendation.

276 Existing Regulatory Status

277 *Endangered Species Act*

278 The U.S. Fish and Wildlife Service listed the Northern Spotted Owl as threatened under the Endangered
279 Species Act in 1990. Critical habitat designation occurred in 1992 and was revised in 2008, and a new
280 final rule designating critical habitat was published in December 2012. The first final recovery plan for
281 the Spotted Owl was issued in 2008 and revised in 2011.

Comment [DK2]: Is this actually true? I thought the NWFP was developed to avoid the designation of “CH” under ESA.....so it was the 2012 document that “officially” designated CH.

282 *Migratory Bird Treaty Act*

283 The Migratory Bird Treaty Act prohibits anyone from taking, killing, or keeping any native bird, its parts,
284 or its nest, without a permit or license. All raptors native to the U.S. are covered by this law. A Special
285 Purpose Possession Permit and/or Endangered Species Permit (depending on species), is required under
286 the Migratory Bird Treaty Act to keep raptors.

287 *California Endangered Species Act*

288 After the Commission voted to accept the petition in December, 2013, the Northern Spotted Owl
289 became a State candidate for threatened or endangered status under the California Endangered Species
290 Act, commencing with section 2050 of the California Fish and Game Code

291 *California Bird Species of Special Concern*

292 The Department currently designates the Northern Spotted Owl as a Species of Special Concern.

293 *Fish and Game Code*

294 The Fish and Game Code includes certain protections for raptors, including the Northern Spotted Owl.
295 Sections applicable to owls include the following:

296 Section 3503 - It is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird,
297 except as otherwise provided by this code or any regulation made pursuant thereto.

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298 Section 3503.5 - It is unlawful to take, possess, or destroy any birds in the orders Falconiformes
299 or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird
300 except as otherwise provided by this code or any regulation adopted pursuant thereto.

301 Section 3513 - It is unlawful to take or possess any migratory nongame bird as designated in the
302 Migratory Bird Treaty Act or any part of such migratory nongame bird except as provided by
303 rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory
304 Treaty Act.

305 *California Board of Forestry and Fire Protection*

306 The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire
307 Protection (CAL FIRE) have designated Northern Spotted Owl as a "Sensitive Species" as identified in the
308 California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules).
309 These sections also define Northern Spotted Owl -related terminology, including "activity center",
310 "Northern Spotted Owl breeding season", and "Northern Spotted Owl Evaluation Area." Specific
311 requirements for the disclosure of information on Northern Spotted Owls in the context of timber
312 harvesting, which in all but one case avoid take of Northern Spotted Owl are provided by Forest Practice
313 Rules sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted
314 Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by
315 CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and
316 related activities, would be avoided according to the criteria for determining take avoidance found in
317 Section 919.10. Other language within Section 919 also compels methods to avoid take of Northern
318 Spotted Owl. Sections 919.2 and 919.3 set up protections of bird nests through buffers and avoidance of
319 sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the
320 protections afforded to late successional forests, which are a component of Northern Spotted Owl
321 habitat.

322 *International Union for Conservation of Nature*

323 The International Union for Conservation of Nature Red List of Threatened Species status for the
324 Spotted Owl range-wide is "Near Threatened" because the "species has a moderately small population
325 which continues to decline in northern and western parts of its range."

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Biology and Ecology of the Northern Spotted Owl

Life History

Species Description

The Northern Spotted Owl is a medium-sized dark brown owl, with a barred tail, white spots on its head and breast, and dark brown eyes surrounded by prominent facial disks (Forsman et al. 1993, Gutiérrez et al. 1995). Overall, its length is approximately 46 to 48 centimeters (18 to 19 inches) (Forsman et al. 1993). Males and females are dimorphic in size, with males averaging about 13 percent smaller than females (USFWS 2011a). Males weigh between 430 to 690 grams (0.95 pound to 1.52 pounds), and females weigh between 490 to 885 grams (1.1 pounds to 1.95 pounds) (P. Loschl and E. Forsman pers. comm. 2006 in USFWS 2011a). The Northern Spotted Owl resembles the Barred Owl in appearance, and first generation hybrids ~~of the two species~~ exhibit physical and vocal characteristics of both [species](#) (Hamer et al. 1994, Kelly and Forsman 2004).

Taxonomy and Genetics

The American Ornithologists' Union recognizes the Northern Spotted Owl as one of three subspecies of Spotted Owls. The two other subspecies are the California Spotted Owl (*S. o. occidentalis*), ranging in the southern Cascade Range of northern California south along the west slope of the Sierra Nevada and in mountains of central and southern California, and [the](#) Mexican Spotted Owl (*S. o. lucida*) ranging from southern Utah and Colorado south to Michoacán, Mexico. The taxonomic separation of these three subspecies is supported by genetic, morphological, and biogeographic information (Barrowclough and Gutiérrez 1990, Gutiérrez et al. 1995, Haig et al. 2004a, Chi et al. 2005, Henke et al. 2005, Barrowclough et al. 2005, Funk et al. 2008, AOU 2011, Barrowclough et al. 2011). The Marin County population of Northern Spotted Owl is genetically isolated from other Spotted Owl populations in California (Jenson et al. 2006).

There is a narrow, apparently stable zone where hybridization occurs between the Northern and California Spotted Owl in the Southern Cascades and Northern Sierra Nevada Mountains near the Pit River in California (Courtney et al. 2004, Barrowclough et al. 2005). There is evidence ~~in all genetic studies conducted on the species~~ of some genetic mixing of California Spotted Owl into the Northern Spotted Owl range, ~~but and~~ fewer examples of the opposite [gene flow](#) (Courtney et al. 2004). In the Klamath region of California, 20.3% of owls were classified as California Spotted Owls (Haig et al. 2004a). Among all Northern Spotted Owls sampled across their range in Oregon, Washington, and California, 12.9% contained California Spotted Owl haplotypes (Haig et al. 2004a). There has been some evidence ~~of for genetic~~ flow between Mexican Spotted Owls and Northern Spotted Owls, primarily in Washington, indicating long-distance dispersal of Mexican Spotted Owls most likely via the Rocky Mountain dispersal route (Funk et al. 2008). Until recently, there has been little evidence in the literature of loss of genetic variation and population bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across the range of the Northern Spotted Owl (Washington Cascade Mountains,

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Oregon Cascade Mountains, Oregon Coast Ranges, and Klamath Mountains of Oregon and California) provides compelling evidence that recent ~~a~~ population bottlenecks may have occurred, with more prominent bottlenecks in the Washington Cascade Mountains as compared to other regions included in the analysis (Funk et al. 2010).

~~Since the~~ The range expansion of Barred Owl into the Northern Spotted Owl range, has resulted in some hybridization between ~~s of the two species have resulted as well~~. The majority of hybrids that have been genetically evaluated with genetic methods ~~have resulted from a cross between a female Barred Owl and a male Spotted Owl~~ (Haig et al 2004b, Kelly and Forsman 2004). First generation hybrids share phenotypic and vocal characteristics of both parent species (Hamer et al. 1994). Second generation hybrids are often difficult to distinguish from Barred or Spotted Owls in the field and genetic testing may be the only sure method of identification (Kelly and Forsman 2004). Both first and second generation hybrids were found to be reproductively viable in some cases (Kelly and Forsman 2004).

Geographic Range and Distribution

The current range of the Northern Spotted Owl extends from southwest British Columbia through the Cascade Range, coastal ranges, and intervening forested lands in Washington, Oregon, and northern California, as far south as Marin County (USFWS 1990). The transition between subalpine to alpine forests marks the upper elevation limit at which Northern Spotted Owls are known to occur (Forsman 1975, Forsman et al. 1984). Prior to the mid-1800s, Northern Spotted Owls are believed to have inhabited most old-growth forests or stands throughout the Pacific Northwest, including northwestern California (USFWS 2011a). Although the overall range is not known to have changed, the Spotted Owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon (USFWS 2011a). Local declines have been observed in many portions of the range (see Status and Trends and Barred Owl sections of this report).

The range has been partitioned into 12 physiographic provinces based on landscape subdivisions with different environmental features (Thomas et al. 1990) (Figure 1). This total range of the Northern Spotted Owl has been estimated to have an extent of 230,690 km² (57 million acres) (USDA and USDI 1994).

The 12 physiographic provinces are distributed across the species' range as follows:

- Four provinces in Washington: Eastern Washington Cascades, Olympic Peninsula, Western Washington Cascades, Western Washington Lowlands
- Five provinces in Oregon: Oregon Coast Range, Willamette Valley, Western Oregon Cascades, Eastern Oregon Cascades, Oregon Klamath
- Three provinces in California: California Coast, California Klamath, California Cascades

In California, the Northern Spotted Owl range runs south as far as Marin County in the Coast Ranges and across the Klamath Mountains of northern California east to the Cascade Range where it meets the range of the California Spotted Owl (*S. o. occidentalis*) near the Pit River (Figure 2). The California Coast

Comment [DK3]: All true, but it's also true that hybridization rates are really pretty low – actually lower than we all expected when the BO invasion started. Gutierrez et al. 2007, Biological Invasions 9:181-196 is the best discussion of at least the information available prior to 2000. I'm not aware of more current published information but I know we're finding relatively few hybrids on the 6 study areas E. Forsman and I oversee here in OR and WA – might change as NSO densities continue to decline (as noted in Gutierrez paper).

Comment [DK4]: You will be able to cite Dugger et al. (2015) very shortly – NSO manuscript detailing status and trends is now "in press".

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Province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of national forest lands. The California Klamath Province is between the California Coast Province to the west and the California Cascades province to the east, and is a continuation of the Oregon Klamath province, with a southern boundary at the Clear Lake Basin in the inner Coast Range. The California Cascades province is bounded on the west by the Sacramento Valley and the Klamath Mountains, on the east by the Modoc Plateau and Great Basin, and to the south by the Sierra Nevada Mountains (USFWS 1992, Courtney et al. 2008).

Broad-scale patterns of relative abundance of Spotted Owls are suggested by the distribution of recorded Northern Spotted Owl activity centers across the landscape. An activity center is a known Northern Spotted Owl site documented from survey detections (See Appendix 2 for a more detailed definition of activity center). Lower interior densities of Northern Spotted Owl are acknowledged in the 2011 Recovery Plan (USFWS 2011a), which states, "...the dry forest portion of the Spotted Owl's range hosts a minority of the overall population..." Records from the Department's Spotted Owl Database indicate that generally activity centers occur at lower densities in the drier portions of the interior Klamath and Cascade ranges, compared to the Coastal Range and wetter portions of the Klamath Province (Figure 3). It appears many activity centers within the Coast Province have been documented only beginning in the 1990s. This is likely due largely to increased survey effort by private timber companies following the listing by the federal government rather than an increase in Spotted Owl territories in the Coast Province, although Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property in Humboldt and Del Norte counties that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature (GDRC 2015). Humboldt Redwood Company has also reported an increase in number of sites since 2008, but acknowledges the possibility that the increase may be due to the displacement of Spotted Owls to new sites as a result of increasing numbers of Barred Owls (HRC 2015). Large timber companies in the coastal portion of the range have identified a large number of activity centers on their ownerships, with more than 200 activity centers on some ownerships. Consistent with the general pattern, private ownerships in the interior have lower densities of Northern Spotted Owls, but some timber companies still host close to a hundred activity centers (Calforests 2014). Caution must be used when examining these data; activity center sites do not represent the actual number or density of owls across the range in California due to the nature the data are collected and reported. Data are often collected inconsistently based on local project-level monitoring needs and not all data is reported to the database. Also, activity centers are generally retained in the database over time regardless of annual occupancy status (see Status and Trends section of this report).

Reproduction and Development

The Northern Spotted Owl is relatively long-lived with a long reproductive life span (Forsman et al. 1984, Gutiérrez et al. 1995), with wild owls living up to 20 years or more. Owls are reproductively mature at 1 year of age, but generally do not reproduce for the first time until 2 to 5 years of age. Courtship initiates in February or March, with the first eggs laid in late March through April (Miller et al. 1985, Franklin 1992, Forsman et al. 2002). Timing of breeding onset varies by latitude and elevation, with delayed

Comment [DK5]: We've got breeders on our demographic study areas that are >20 years old, so 25 years is probably closer to the upper end. Some of this age information can be found in the annual reports for the demographic study areas (<http://www.reo.gov/monitoring/reports/northern-spotted-owl-reports-publications.shtml>) – for example we had a 20-year old female on HJA in OR that was banded as an "adult" so it was at least 23 years old.

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438 nesting occurring at higher elevations and latitude (Forsman et al. 1993). Females typically lay 1 to 4
439 eggs per clutch, with 2 eggs per clutch most common (Forsman et al. 1984, USFWS 1990, Anthony et al.
440 2006). Incubation, performed exclusively by the female, lasts about 30 days (Courtney et al. 2004).
441 Brooding is almost constant for the first 8 to 10 days and is also done exclusively by the female, after
442 which the female will take short trips off of the nest to hunt (Courtney et al. 2004). The male provides all
443 the food to the nest during incubation and the first 10 days of brooding (Courtney et al. 2004). Chicks
444 fledge from the nest in late May or in June and continue to be dependent on their parents into
445 September until they are able to fly and hunt for food on their own (Forsman et al. 1984, USFWS 1990).
446 Adults can typically be found roosting with young during the day for the first few weeks after they leave
447 the nest, after which adults typically only visit their young during the night to deliver food (Forsman et
448 al. 1984). By November, most juveniles begin to disperse (Miller et al. 1997, Forsman et al. 2002,
449 Courtney et al. 2004).

450 Most individual Spotted Owls do not always breed every year, and strong biennial patterns in breeding
451 propensity and reproductive success are observed throughout their range (Anthony et al. 2006, but
452 more normally breed every other year (Forsman et al. 2011, Dugger et al. In press). The reason for this
453 biennial breeding pattern is unknown, but may be due to the large time investment and energy cost to
454 produce young (Forsman et al. 2011), although recent research suggests the costs of reproduction are
455 not responsible for these patterns in California Spotted Owls 2011 (Stoelting et al. 2015). Annual
456 variation in reproductive success may is thought to be related to weather conditions and fluctuations in
457 prey abundance, but may also be related to individual variation, age, and habitat quality within the
458 territory (Forsman et al. 1993, Forsman et al. 2011). Small clutch size, temporal variation in nesting and
459 nest success, and low productivity by young birds (<3 years of age) at onset of breeding maturity all
460 contribute to low annual fecundity for the Northern Spotted Owl (Gutiérrez 1996).

461 Density

462 Density (i.e., number of individuals per unit of area) estimates for Northern Spotted Owl are difficult to
463 obtain due to the level of effort required to survey all potential habitat in a given area. Density has been
464 estimated for specific study areas, but not across the species' entire range; several estimates of density
465 are available from sites in California (Table 1). Franklin et al. (1990) estimated crude density (territorial
466 owls/km²) of owls in the Willow Creek Study Area, Humboldt County, at 0.235 owls/km² (95% CI =
467 0.214-0.256), and ecological density (number of individuals/ km² of habitat) at 0.544 owls/km² (95% CI =
468 0.495-0.592) and 0.660 owls/km² (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density
469 in Redwood National Park, Humboldt County, to be 0.219 owls/km². Diller and Thome (1999) estimated
470 crude density for owls in their northern California coast study area in Humboldt, Trinity and Del Norte
471 counties to be 0.092 owls/km²±0.006, 0.351 owls/km²±0.011, and 0.313 owls/km²±0.017 for Klamath,
472 Korbelt and Mad River regions respectively, with an overall mean density of 0.209 owls/km²±0.009.
473 Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbelt, and
474 Mad River respectively (Diller and Thome 1999). The 2015 annual report for Green Diamond Resource
475 Company Northern Spotted Owls Habitat Conservation Plan (GDRC 2015) notes a density of 0.17
476 owls/km² in the northern portion of their land in Humboldt County, and 0.78 owls/km² in southern

Comment [DK6]: Birds do breed at 1 and 2-years of age – just not many and not very successfully. Even in the world of “delayed maturation”, not breeding until 3 years of age is not really that “delayed” – at least compared to other birds (seabirds) with similar lifespans (~25 years) that don’t breed until 5 or 6 years of age.

Comment [DK7]: See several new publications on the CA owl that will help this discussion.

Peery and Gutierrez (2013): Auk 130:132-140

Stoelting et al. (2015): Auk 132:46-64 – this one in particular suggests that “cost of reproduction” is not responsible for EO variation in reproductive success and/or breeding propensity.

Comment [DK8]: I don’t think density is really a great metric – hard to measure as you note, but also really difficult to understand if you don’t have good information on how much suitable habitat is actually available to owls (what is density relative to the actual space available for NSO to exist?).

Probably better to evaluate “occupancy” and “rate of population change” on study areas in CA. So see Anthony et al. 2006, Forsman et al. 2011, annual reports for Willow Creek area (Franklin et al.) and of course Dugger et al. (now in press).

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portions. Sierra Pacific Industry reported 0.450 owls/km² between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km² between 2011 and 2013 on their lands in Trinity, Siskiyou, Shasta, Modoc and Lassen counties (Roberts et al. 2015). In Mendocino County, Mendocino Redwood Company reported a density of 1.89 occupied territories/km² of area surveyed (MRC 2014). Lastly, Humboldt Redwood Company (HRC) reported 1.22 occupied territories/km² and 2.23 owls/km² of area surveyed on their lands in Humboldt County (HRC 2013).

Table 1. Density estimates for Northern Spotted Owls within various study areas throughout the range in California.

Source	Density Measure	Location
Franklin et al. 1990	0.235 territorial owls/km ² 0.544 number of owls/ km ² of habitat 0.660 number of owls/ km ² of habitat	Willow Creek Study Area in Humboldt County
Tanner and Gutiérrez1995	0.219 owls/km ²	Redwood National Park in Humboldt County
Diller and Thome 1999	0.092 owls/km ² (Klamath) 0.351 owls/km ² (Korbel) 0.313 owls/km ² (Mad River) 0.209 owls/km ² (mean)	Northern California coast study area in Humboldt, Trinity and Del Norte counties
GDRC 2015	0.170 owls/km ² (northern) 0.780 owls/ km ² (southern)	Green Diamond Resource Company land in Humboldt County
Roberts et al. 2015	0.450 owls/km ² between 1989 and 2003 0.450 owls/km ² between 2003 and 2007 0.459 owls/km ² between 2011 and 2013	Sierra Pacific Industry lands in Trinity, Siskiyou, Shasta, Modoc and Lassen* counties
MRC 2014	1.89 occupied territories/km ² of area surveyed	Mendocino Redwood Company in Mendocino County
HRC 2013	1.22 occupied territories/km ² of area surveyed 2.23 owls/km ² of area surveyed	Humboldt Redwood Company in Humboldt County

* Densities were reported for Modoc and Lassen counties in this study; however these counties are not within the range of the Northern Spotted Owl. Sierra Pacific Industry lands in this study overlap with the Northern Spotted Owl and California Spotted Owl ranges.

As apparent from the reports of density estimates above, there is considerable variation among studies even though most studies occurred within the coastal forests. This variation in density may be attributed to habitat availability, habitat heterogeneity, territoriality, weather patterns, and presence of Barred Owls (Franklin et al. 1990, Diller and Thome 1999, Courtney et al. 2004 Sovern et al. 2014). Another possible explanation of the variation is that data collection and analysis varied among the studies. Given this, it is nearly impossible to extrapolate density across the entire California range for Northern Spotted Owl.

Comment [DK9]: See above. Density is not a helpful metric, particularly without some idea of “change” in density over time. What do these density estimates mean in regards to actual status of NSO in CA?

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495 *Hunting and Food Habits*

496 As described in Forsman et al. (1993), Northern Spotted Owls are sit and wait (e.g., perch and pounce)
497 predators. They mostly hunt during nighttime hours (i.e., nocturnal), but will forage during the day as
498 well (Forsman et al. 1984, Sovern et al. 1994, Forsman et al. 2001). Generally, flying squirrels are the
499 main component of the diet in Douglas-fir and western hemlock forest within the northern portion of
500 the owl's range (in Washington and Oregon); whereas in the southern portion of the range (Oregon
501 Klamath, California Klamath, and California Coastal Provinces) dusky-footed woodrats are the main
502 component of the diet (Forsman et al. 1984, 2001, 2004, Zabel et al. 1995, Ward et al. 1998, Franklin et
503 al. 2000, Hamer et al. 2001, ~~Dugger et al. 2005~~). Other prey items seen in the owl's diet in smaller
504 proportions include deer mice, tree voles, red-backed voles, gophers, snowshoe hare, bushy-tailed
505 woodrats, small to medium sized birds, bats, and insects (Forsman et al. 1984, 2001, 2004, Ward et al.
506 1998, Hamer et al. 2001). A study within the Southern Cascades and Klamath Provinces in California
507 (Timber Products Company timberland) identified 16 species of mammals, 5 species of birds, and 1
508 species of insect among 224 pellets collected, with major prey items being 58.3% woodrat sp., 29.2%
509 Northern flying squirrel, 3.9 % broadfooted mole, 3.9% rabbit and 1.4% gopher (Farber and Whitaker
510 2005).

511 Diet analysis conducted in Washington during the fall and winter months indicated seasonal variation in
512 prey species consumed as a function of the availability of the owls preferred prey species during various
513 portions of the year (Forsman et al. 2001). In the Washington study area, flying squirrels were more
514 prevalent in the diet during fall and winter months, whereas prey species that hibernated or spent the
515 winter under the snow (e.g., chipmunks and pikas) were missing from the diet during the same period.
516 During the spring, summer and early fall months consumption of insects, gophers, and snowshoe hares
517 occurred more frequently (Forsman et al. 2001). Forsman et al. (2001) noted that diets varied among
518 territories even within the same forest type with much of the variation attributed to differences in
519 spatial abundance of prey, but other factors, such as individual preferences, experience, prey
520 accessibility, or timing of pellet collection, may have played a role. While the populations in California
521 are geographically distinct, and hunting and food habits may differ somewhat from owls in Washington,
522 Northern Spotted Owls in California likely vary diet seasonally according to the spatial distribution and
523 abundance of their preferred prey.

524 ~~Basal metabolic rates (BMR) of Metabolic measurements made on~~ California Spotted Owls are very low
525 ~~relative to BMR for other owl species (in~~ Weathers et al. (2001), ~~showed very low basal metabolic rates~~
526 ~~compared to other owl species, thereby leading to suggesting~~ very low energy requirements for Spotted
527 ~~Owls~~. Field metabolic rate on adults actively caring for young averaged only 34% of the metabolic rate
528 predicted for other avian species of the same size (Weathers et al. 2001). Considering this low metabolic
529 rate, ~~Weathers et al. (2001) found that,~~ on average, owls can meet their energy requirements by
530 consuming one northern flying squirrel every 1.8 days or one woodrat every 3.7 days (Weathers et al.
531 2001). ~~Similar work has not been conducted for Northern Spotted Owls. This low metabolic~~
532 ~~requirement is likely similar to that of Northern Spotted Owls, though no known study has been~~
533 ~~conducted on this subspecies.~~

Comment [DK10]: Be sure you are only citing work here that actually reports on diet directly – so based on pellet data or other direct observations.

Comment [DK11]: I did not look at diet directly, but rather cite Forsman unpubl data.- unfortunately not a lot of published literature on NSO diets in S. Oregon or CA (but see Forsman et al. 2004, Zabel et al. 1995

Comment [DK12]: See Wiens et al. 2014 Wild. Mono 185 as well.

Comment [DK13]: Not sure any of this is relevant to your focus on CA NSO.....

Comment [DK14]: Not sure I agree. Lots of factors might go into this – phylogeny (i.e., evolutionary similarities), distribution (habitat characteristics, temperature and precip conditions), and variation in prey species.

Comment [DK15]: Not sure this paragraph works well here as a “stand-alone” point. Might go better in the diet section above – particularly as you are trying to make a case for the importance of woodrats in CA -

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There is strong evidence that prey abundance and availability affect selection and use of habitat and home range size of Northern Spotted Owls across their range (Zabel et al. 1995). In northwest California, Northern Spotted Owls were found to forage in areas where the occurrence of prey was more predictable, within older forests, and near ecotones of old forest and brush seral stages (Ward 1990 as cited in USFWS 2011a). Owls tend to have larger home ranges and select old-growth forests with less edge habitat for foraging and have larger home ranges when flying squirrels are the dominant prey item (Courtney et al. 2004). Conversely, in southern parts of their range where wood rats are more common in the diet, whereas home ranges are smaller and include more they tend to select variable-aged stands with more edge habitat when woodrats are the dominant prey (Courtney et al. 2004). However, while in these variable-aged stands are important foraging habitat, older forests remain an important component of nesting and roosting habitat through the Spotted Owls' range (Citation.....). Where woodrats are the dominant prey, the amount of edge between older forests and other habitat types in Oregon was found to have a positive effect on foraging success and subsequent reproductive success due to increased prey availability (Olson et al. 2004). Where woodrats are the primary prey item, young seral stages often provide high quality prey habitat but provide limited foraging opportunities for Spotted Owls due to a lack of perches from which to hunt or to prey inaccessibility in the dense undergrowth; however, when young seral forests are adjacent to older forest stands surplus woodrats may disperse into these older forests making them more vulnerable to predation by Spotted Owls (Meyer et al. 1998, Franklin et al. 2000, Zabel et al. 2003, Olson et al. 2004). In the northwestern California coast redwood zone and the mixed conifer forests in the interior of the California range near Yreka, California, studies have shown that Spotted Owls will forage in recent harvest-created hardwood and shrub habitat (i.e., within 6-30 year old clearcuts) that contain woody debris, scattered conifers and snags, and that are adjacent to older forests (Irwin et al. 2013). Winter use of these areas was more pronounced in areas with 9-18 m²/ha basal area (Irwin et al. 2013).

Home Range and Territoriality

Northern Spotted Owls are territorial. Territories are actively defending territories ed using aggressive vocal displays, and even physical confrontations on the rare occasions (Courtney et al. 2004). Because of their high territoriality, broadcast surveys are generally a very effective method for determining presence of Spotted Owls (Courtney et al. 2004 Reid et al. 1999); however, calling may be suppressed by the presence of Barred Owls (see Barred Owl section of this report). Territory size for Northern Spotted Owls varies depending on the setting and structure of the habitat (e.g., canopy closure, understory composition, and slope), number of available nesting and roosting sites, and location relative to suitable foraging habitat (Courtney et al. 2004). In general, Spotted Owls have a broad home range with a centrally located nest and roosting site. For this reason, Spotted Owls are considered central place foragers during the breeding season when they are tied to a central nesting or roosting site. Spotted Owls often occupy a home range that is larger than the core use area, and may use an area that is larger than the portion of the home range which is defended (i.e., home ranges may overlap with that of other Spotted Owls). Northern Spotted Owl home ranges generally have a greater amount of older forest near the nest and within the core area use, and more diverse forest types and ages on the periphery of their ranges (Swindle et al. 1999).

Comment [DK16]: So I think what you're trying to say is in regards to foraging habitats, but this section is a bit muddled and it isn't always clear that you are making a distinction between foraging and nesting/roosting. Not sure my edits helped, but I think it's more in line with what you probably mean. In addition, there are better, more specific citations than Courtney et al. 2004 that should be incorporated here.

Glenn et al. 2004. JWM 68:
Forsman et al. 2004. JRaptor Res 38.
Hamer et al. 2007. Condor 109:
Irwin et al. 2011 JWM 76:
McDonald et al. JWM 70:
Schilling et al. 2013. JRaptor Res 47:
Wiens et al. 2014

Comment [DK17]: Also see Schilling et al. 2013 – some trade-off between edge and maybe access to prey, but also negative effects of too much old forest fragmentation.....

Comment [DK18]: Must be an early Forsman paper that would be the primary citation for this statement and preferable to Courtney et al.

Comment [DK19]: Again, not your best citation – see list above regarding foraging habitat use, etc. for the primary literature.

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Estimates of annual home range size vary across the Northern Spotted Owl's range (Table 2). The 1990 Conservation Strategy for Northern Spotted Owls (Thomas et al. 1990) reports median annual home range size of owl pairs in various study areas throughout the species' range. Table 2 summarizes home range estimates across the range of the Northern Spotted Owl. Home range estimates from various studies are reported using different analytical tools (e.g., Minimum Convex Polygon, Modified Minimum Convex Polygon, Fixed Kernel, and Adaptive Kernel) and are identified as such in Table 2. Median home range sizes in Oregon and Washington varied from a low of 1411 acres in the mixed conifer forests of the Klamath Mountains (South Umpqua) to a high of 9930 acres in Washington's Olympic Peninsula, consisting mostly of western hemlock with Douglas-fir (Thomas et al. 1990). More recently, Schilling et al. (2013) documented considerably smaller home range sizes ranging from 189 to 894 hectares (467 to 2209 acres) were documented in southwestern Oregon's mixed conifer forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference between breeding and nonbreeding seasons, although the study showed core area size, annual home range and breeding home range size increased as the amount of hard edge increased (Schilling et al. 2013). In their study site Conversely, in the dry forests of the eastern Cascades in Washington, Forsman et al. (2015) found considerable difference between breeding home range and non-breeding home range was observed, with home ranges being 3.5 times larger during the fall and winter months compared to the breeding season (Forsman et al. 2015).

Home range of Northern Spotted Owls may overlap with those of other neighboring owl pairs, suggesting that the defended area (i.e., territory) is smaller than the area used for foraging (Forsman et al. 1984, Solis and Gutiérrez 1990, Wiens et al. 2014, Forsman et al. 2015). Northern Spotted Owl home ranges are larger where flying squirrels are the predominant prey, in the northern portion of the range, and smaller where woodrats are the predominant prey, in the southern portion of their range, presumably due to differences in predominant prey types (Zabel et al. 1995, Forsman et al. 2001). Woodrats provide twice the biomass of flying squirrels and therefore are more energetically favorable, which likely explains the smaller home range in the owl's southern portion of the range where woodrats are predominant in Spotted Owl diets (Ward et al 1998, Franklin et al. 2000). The portion of the home range used during the breeding season can be significantly smaller than that used in the remainder of the fall and winter (Forsman et al. 1984, Sisco 1990 as cited in USFWS 2011a, Forsman et al. 2015), possibly due to. Forsman et al. (2015) attributes the larger winter home range to prey dynamics and exploratory excursions in search of better habitat during the winter (Forsman et al. 2015).

Comment [DK20]: See Wiens et al. 2014 for current info from Coast Range, OR

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606 **Table 2.** Summary of annual home range and core home range sizes across the range of the Northern Spotted Owl. MCP = Minimum Convex Polygon, MMCP =
607 Modified Minimum Convex Polygon, FK = Fixed Kernal, and AK = Adaptive Kernal.

Area	Annual Home Range in hectares (+/- one Standard Error)				Core area in hectares	Source
	MCP	MMCP	95% FK	95% AK		
Oregon Coast	1569(463)	1018(160)				Carey et al. 1992
Oregon Coast	1108(137) to 2214(357)		842(115) to 1344(247)		87(6) to 100(5) 95% FK	Glenn et al. 2004
Oregon Coast	2272 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
Oregon Coast	2586 (median)					Thraikill and Meslow pers comm. (as reported in Thomas et al. 1990)
Oregon Coast	1693 (median)					Carey et al. 1990 (as reported in Thomas et al. 1990)
Oregon Klamath	533(58)	472(43)				Carey et al. 1992
Oregon Klamath			576(75)		94(11) 95% FK	Schilling et al. 2013
Oregon Western Cascades	3066(1080)				417(129) AK	Miller et al. 1992
Washington Eastern Cascades	3419(826)		2427(243)			Forsman et al. 2015
Washington Eastern Cascades	3669(876)					King 1993
Washington Western Cascades	2553 (median)					Various references as reported in Thomas et al. 1990
Washington Olympic Peninsula	4019 (median)					Various references as reported in Thomas et al. 1990
California Klamath	1204 to 1341 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
California Klamath	685 (median)					Solis 1983 (as reported in Thomas et al. 1990)
California Coast	786(145)			685(112)	98(22) 95% AK	Pious 1995

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608 *Dispersal*

609 As discussed above, juveniles begin to disperse in the fall, with a few individuals beginning to disperse in
610 early winter. Juvenile dispersal from the parental territory occurs in stages, as juveniles may temporarily
611 settle in locations for up to 7 months before moving on to another temporary location, which may occur
612 several times before individuals establish a territory of their own (Miller et al. 1997, Forsman et al.
613 2002). LaHaye et al. (2001) found that successful juvenile California Spotted Owls often settled in
614 territories previously used by pairs or single owls, which may suggest that owls were able to use some
615 sort of cues that indicated some value of habitat quality when determining a territory of their own
616 (Buchanan 2004).

617 In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent
618 territory was between 13.5 and 14.6 km (8.4-9.1 mi) for males and between 22.9 and 24.5 km (14.2-15.2
619 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted
620 Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while
621 juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). While the only
622 data available on dispersal pertains to Northern Spotted Owls in Washington and Oregon, and California
623 Spotted Owls in California, we can extrapolate that Northern Spotted Owls in California act similarly,
624 because, while the populations are genetically and geographically distinct, they still share many
625 ecological and behavioral characteristics.

626 Juvenile Northern Spotted Owls experience high mortality rates (>70% in some areas) during dispersal
627 due to a variety of factors including starvation, predation, and vehicle strikes (Miller 1989, Franklin et al.
628 1999, USFWS 1990, Forsman et al. 2002). Habitat type used during dispersal may also have an effect on
629 mortality. Miller et al. (1997) found that the probability of mortality decreased when dispersing
630 juveniles utilized open sapling forests, but increased when clear cuts were utilized. Successful juvenile
631 dispersal likely depends on locating suitable nesting, roosting and foraging habitat in proximity to other
632 occupied sites or among occupied sites (LaHaye et al. 2001), as well as the presence of suitable habitat
633 to disperse through (Miller et al. 1997, Buchanan 2004).

Comment [DK21]: See Sovern et al. (2015) JWM 79 for more on habitat use during dispersal in WA.

634 **Habitat Requirements**

635 Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western
636 hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and
637 redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally
638 use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al.
639 1990, Carroll and Johnson 2008, Carroll 2010, USFWS 2011); however, younger forest stands with
640 structural components similar to older forests may also be used by Spotted Owls (USFWS 2011a). The
641 edge between old-growth forest and other vegetation types have also been shown to be important
642 habitat components in some portions of the species' range (Franklin et al. 2000).

Comment [DK22]: Never found to be important farther north than mid-Oregon.

643 Throughout the Northern Spotted Owl's range in Washington, Oregon, and California, Bart and Forsman
644 (1992) found owls were about 40 times more common in areas with older forest compared to areas

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645 lacking older forest. In Western Oregon, Meyer et al. (1998) determined that random owl sites
646 contained more old-growth forest than random locations on the neighboring landscape. In
647 Northwestern California, Northern Spotted Owls used old-growth with a higher frequency relative to
648 this forest age class' distribution on the landscape, and similarly, used intermediate to young forests
649 with a lower frequency (Solis and Gutiérrez1990 and Thome et al. 1999).

Comment [DK23]: See Dugger et al. 2011 for relationship between habitat and occupancy rates, which would probably be useful here.

650 Discussions on habitat components below address range-wide knowledge of Northern Spotted Owl
651 habitat, as well as knowledge of owl habitat specific to California. This report addresses habitat
652 requirements with a focus on major geographic provinces in California. When considering the enormous
653 amount of research on Northern Spotted Owl habitat, careful consideration should be given to
654 California-specific research when evaluating habitat requirements for the species in the state, and in
655 forming conservation and management decisions.

656 *Nesting and Roosting Habitat*

657 Habitat selection has largely been evaluated for nesting and roosting habitat by comparing habitat
658 surrounding occupied Spotted Owl sites to randomly selected sites (Solis and Gutiérrez 1990, Bart and
659 Forsman 1992, Hunter et al. 1995, Thome et al. 1999). Descriptions of nesting and roosting habitat were
660 provided in the early- to mid- 1990s (Solis and Gutiérrez 1990, Thomas et al. 1990, Bart and Forsman
661 1992) and have been validated by extensive research across most of the range of Northern Spotted Owl
662 (Gutiérrez et al. 1995, Hunter et al. 1995, Meyer et al. 1998, Lahaye and Gutiérrez1999, Swindle et al.
663 1999, Weathers et al. 2001, Courtney et al. 2004, USFWS 2008a, USFWS 2011a).

664 The following description of nesting and roosting habitat from the Conservation Strategy for the
665 Northern Spotted Owl (Thomas et al. 1990) remains an accurate portrayal of what we know today
666 throughout the range of the owl:

667 "With the exception of recent studies in the coastal redwoods of California, all studies of habitat
668 use suggest that old-growth forests are superior habitat for northern Spotted Owls. Throughout
669 their range and across all seasons, spotted owls consistently concentrated their foraging and
670 roosting in old-growth or mixed-age stands of mature and old-growth trees. Exceptions were
671 found, but even they tended to support the usual observations that spotted owls nested in
672 stands with structures characteristic of older forests....Structural components that distinguish
673 superior spotted owl habitat in Washington, Oregon, and northwestern California include: a
674 multilayered, multispecies canopy dominated by large (>30 inches dbh) conifer overstory trees,
675 and an understory of shade-tolerant conifers or hardwoods; a moderate to high (60-80 percent)
676 canopy closure; substantial decadence in the form of large, live coniferous trees with
677 deformities- such as cavities, broken tops, and dwarf mistletoe infections; numerous large
678 snags; ground cover characterized by large accumulations of logs and other woody debris; and a
679 canopy that is open enough to allow owls to fly within and beneath it."

680 Although this habitat description accurately describes high quality nesting and roosting habitat
681 throughout the range of the Northern Spotted Owl, recent research has shown that Spotted Owls in

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682 California and portions of southwest Oregon use a more diverse set of forest types for foraging. This is
683 described more fully in the Foraging Habitat section of this report.

684 Forested stands with a higher degree of complexity and a high canopy closure are thought to be
685 preferred for nesting and roosting, in part, because they provide protection from predators and thermal
686 exposure (Weathers et al. 2001, Franklin et al. 2000). Hunter et al. (1995) determined nest and roost
687 sites occurred more frequently in mature and old-growth forest in northwestern California (Willow
688 Creek Study Area) relative to availability of these forest types' on the landscape. Both nest and roost
689 sites had similar amounts of mature and old-growth forest types. Whereas sites used for nesting and
690 roosting in the coastal forests of California often contain younger trees than more interior nesting and
691 roosting sites. In the California Coast Province, young redwood forests along the coast have structural
692 complexity similar to that of older forests elsewhere in the Northern Spotted Owl's range. This is due to
693 stump-sprouting and the rapid growth rates of redwoods, together and variable timber management
694 practices (Thomas et al. 1990, Thome et al. 1999, USFWS 2011a, Irwin et al. 2013).

695 Small-scale spatial habitat requirements in the immediate vicinity of the nest are important but not
696 sufficient to support all activities (e.g., roosting and foraging) conducted at the larger spatial scale
697 (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, USFWS 2011a). Consequently, nesting and
698 roosting habitat is often only a small portion of the entire home range (Forsman et al. 1984, Solis and
699 Gutiérrez 1990, USFWS 2011a).

700 To assess the success of the coordinated forest management plan for federal lands, the Northwest
701 Forest Plan (NWFP; see Northwest Forest Plan section of this report), Davis et al. (2011) developed a
702 habitat suitability map for nesting and roosting habitat across the Northern Spotted Owl range (Figure
703 4). The habitat suitability model was developed using MaxEnt model output, including variables for
704 percent conifer cover, average conifer dbh, amount of large conifer (trees >30 in dbh per acre),
705 diameter diversity, average stand height, and average stand age. Much of the highest suitable habitat is
706 within northwestern California (inclusive of the northern most portion of the California Coast Province
707 and the western portion of the California Klamath Province) and along the coastal forests.

708 *Foraging Habitat*

709 Compared to nesting and roosting habitat, foraging habitat occurs over a much larger portion of the
710 Northern Spotted Owl's home range, often quite distant from the nesting or roosting site. Within a
711 Spotted Owl home range, foraging habitat use may vary seasonally, with a larger area and younger
712 forests used in the non-breeding period (Forsman et al. 1984, Solis and Gutiérrez 1990, USFWS 2011a).
713 Overall foraging habitat consists of areas where the prey species occur and are available (Ward 1990,
714 Zabel et al. 1995).

715 In California, foraging habitat is generally composed of a more diverse set of forest types and structural
716 characteristics than nesting and roosting habitat. Spotted Owls are difficult to observe during nighttime
717 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and
718 roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry

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719 studies that document owl locations throughout nighttime movements. Although it is difficult to
720 determine when and where owls are actually obtaining prey, telemetry does provide information on the
721 diversity of forest types used during foraging excursions.

722 There is a general shift in foraging habitat requirements from north to south within the Northern
723 Spotted Owl range, with foraging habitat in the northern portion of the range being composed of mostly
724 older forests, and in California being composed of a diverse range of forest types from mature to
725 relatively young (USFWS 2009). In the northern portion of the Northern Spotted Owl range where flying
726 squirrels are the dominant prey, foraging habitat may have the same characteristics as nesting and
727 roosting habitat (Gutiérrez 1996, USFWS 2011a). Whereas in the southern portion of their range, where
728 woodrats and voles are the predominant prey species, foraging habitat may include tanoak, oak and
729 younger conifer stands that provide a food source for these prey species (Franklin et al. 2000, USFWS
730 2009).

Comment [DK24]: It's not that "foraging requirements" shift – well they do, but only because the habitat composition changes, with more heterogeneity and diversity in stand structure found in the south (and along coast), so NSO have adapted to foraging in these habitats on associated prey species (i.e., less contiguous conifer).

731 Landscape-level analyses in portions of the Klamath Province, where woodrats are the main prey item,
732 suggest that a mosaic of late-successional forests intermixed with various other seral stages may benefit
733 Northern Spotted Owls more than large, uniform blocks of older forests (Meyer et al. 1998, Franklin et
734 al. 2000, Zabel et al. 2003). Irwin et al. (2012) found in Oregon and northwestern California that
735 Northern Spotted Owl foraging habitat appeared to be maximized in patches of trees with average
736 quadratic mean diameter¹ of 40 to 55 cm (15-22 inches). Probability of an area being selected for
737 foraging declined rapidly beyond 200 to 300 m (0.12-0.19 miles) from a nest site, yet increased with
738 basal area of hardwoods and with increases in shrub counts (except in areas with high abundance of
739 hardwoods and shrubs).

740 Within the northern Sierra Nevada Mountains, similar to the mixed conifer Cascade mountain range,
741 Irwin et al. (2007) used radio-telemetry data to assess foraging use parameters of California Spotted
742 Owls. Topography, forest density and heterogeneity, and tree species composition all influenced
743 foraging habitat selection, which in this case was driven by the habitat of the preferred prey, dusky-
744 footed woodrat. Foraging was closely associated with forest stands next to nests and small streams at
745 lower elevations. Intermediate basal area values (35-55 m²/hectares) for Douglas-fir, white fir, and red
746 fir and hardwoods ≥20 cm (≥8 inches) were all positively correlated to foraging habitat use. Owls
747 foraged in sites with an average tree density of 1160 trees/hectare, foraged in stands with 17 large
748 green (>66 centimeter or >26 inch diameter) trees/ha. Use declined with increasing basal area of
749 ponderosa pine. Foraging areas were not strongly associated with roads, slope or aspect.

750 As noted previously in this report, several studies have shown a benefit of edge habitat for Northern
751 Spotted Owls (but see Dugger et al. 2005), as certain habitat types that border older forest may contain
752 higher numbers of preferred prey (Carey et al. 1992, Sakai and Noon 1993, Hamm et al. 2002), the dusky

Comment [DK25]: Some studies in southern OR have also found no relationship with edge.....i.e., Dugger et al. 2005

¹ Compared to the arithmetic mean, quadratic mean diameter, or QMD, assigns greater weight to larger trees. QMD is always greater than or equal to the arithmetic mean for diameter at breast height for a given set of trees.

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footed woodrat, and surplus prey may venture into older forests that border habitat where prey is abundant making them more available to foraging owls (Sakai and Noon 1997, Zabel et al. 1995, Thome et al. 1999, Franklin et al. 2000, Franklin et al. 2013). For instance, Zabel et al. (1995) often found Spotted Owls foraging near transitions between early- and late-seral stage forests stands in northern California, likely where prey species were more abundant or more readily available. Franklin et al. (2000) conducted a modeling effort in northwestern California to help explain variation in both apparent survival and reproductive output. The study found that one of the best models contained a covariate representing the amount of edge between Spotted Owl (defined in the study as mature and old-growth forests with particular characteristics) and other habitats, thereby suggesting that reproductive output and survival are positively influenced by amount of edge, presumably due to increased availability of prey. However, foraging owls have been shown to avoid non-forested areas (e.g., recent clearcuts) and very early forest successional stages (USFWS 2011a, Irwin et al. 2013).

Dispersal Habitat

Generally, it is well accepted that dispersal habitat for Northern Spotted Owls consists of stands with adequate tree size and canopy closure to provide protection from avian predators and that have at least minimal foraging opportunities (Miller et al. 1997, Thomas et al. 1990, Forsman et al. 2002, Buchanan 2004, USFWS 2011a). This may include younger forest stands with less diversity than nesting and roosting habitat, such as even-aged and pole stands, but should at the minimum contain some roosting structures and foraging habitat during this transient stage (Davis et al. 2011, USFWS 2011a). The latest meta-analysis (Forsman et al. 2011) indicates that recruitment of owls into the breeding population likely depends on the amount and quality of dispersal habitat to ensure survival of dispersing owls.

Spotted Owls have been shown to disperse through highly fragmented forest landscapes and seem to use mature and old-growth forests more than that forest type's availability on the landscape during this phase (Miller et al. 1997, Forsman et al. 2002). The USFWS (USFWS 2011) states that corridors of dispersal habitat within fragmented landscapes act to facilitate rapid movement to areas of better habitat. There is little evidence that small openings in forest habitat influence the dispersal of Spotted Owls, but large non-forested valleys may act as barriers to both natal and breeding dispersal (Forsman et al. 2002). Water bodies may also function as barriers to dispersal, but this is not clearly understood (Forsman et al. 2002).

Thomas et al. (1990) suggests juvenile movement corridors need not be provided on the landscape outside of areas managed as nesting and roosting habitat if 50% of the forest measured on a quarter township basis is forested by trees with average diameter >11 inches and >40 percent canopy closure (i.e., the 50-11-40 rule). Regarding this rule, the USFWS Recovery Plan (2011) states, "the minimum levels of this definition describe habitat supporting the transient phase of dispersal."

A clear understanding of dispersal habitat is key to the management of owl habitat across the Northern Spotted Owl's range. Buchanan (2004) stressed the importance of appropriate management of dispersal habitat and suggests that one of the greatest inadequacies of Spotted Owl habitat management is the lack of retention of structurally complex forest components, such as snags and downed woody debris, at

Comment [DK26]: I don't think any of these studies actually documented this happening – Sakai and Noon 1997 is the only study I'm aware of that actually studies woodrat movements.

Comment [DK27]: Actually, this is largely a belief that has rarely been critically tested (as it's hard to document habitat use of juvenile NSO). See Sovern et al. 2015 – JWM 79 -

Comment [DK28]: See Sovern et al. 2015 – I don't believe this "rule" was based on any real data and it should not be the basis for management without more information on not just habitat use, but demographics related to that habitat use during dispersal.

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791 the time of or post timber harvest. Additional studies in California, such as radio telemetry on juvenile
792 owls, prey abundance and availability, and habitat modeling, are required in order to elucidate specific
793 habitat requirements for and barriers to dispersal.

794 In an attempt to document the level of change in dispersal habitat, Davis et al. (2011) developed
795 dispersal habitat maps for 1994-2007 using Global Information Systems (GIS), using variables for conifer
796 dbh ≥ 11 inches and conifer cover ≥ 40 percent (Figure 5). The maps also included some amount of
797 nesting and roosting habitat since owls will disperse through these habitat types. Dispersal habitat is
798 continuous in large portions of the northern range in California, with small isolated patches north of
799 Point Arena and in Marin County, in the California Coast Province.

800 *Northern Spotted Owl Habitat Descriptions for Geographic Provinces in California*

801 The forest types within the California range are quite diverse, and consequently, Northern Spotted Owls
802 use the habitat differently among these forest types. Historically the range of the Northern Spotted Owl
803 has been separated into 12 physiographic provinces based on differences in vegetation, soils, geologic
804 history, climate, land ownership and political boundaries (USFWS 2011a; Figure 1); of which three
805 provinces are in California – California Coast, California Klamath, and California Cascade. To better
806 understand the range of forest types used and regional differences that influence habitat quality in
807 California, general owl habitat within each province is described below.

808 In addition to province segregations, habitat modeling conducted for the 2011 Revised Recovery Plan
809 (USFWS 2011a) identified 11 modeling regions range-wide, five of which occur in California (Figure 6).
810 These modeling regions were developed to capture regional differences in forest environments in
811 acknowledgement of the fact that Northern Spotted Owls exhibit different habitat associations in
812 various portions of their range, and focused on differences in habitat rather than political boundaries or
813 ownership type. For this reason, four of the five modeling regions in California extend into Oregon
814 where similar habitat occurs. Modeling regions that overlap with the California Coast, California Klamath
815 and California Cascade provinces are described below under the appropriate province description.

816 California Coast Province

817 A description of the California Coast province is noted below, as defined in the 1992 Northern Spotted
818 Owl recovery plan (USFWS 1992):

819 “The California Coast province extends from the Oregon border to San Francisco Bay and from
820 the ocean to the western border of national forest lands. The coastal part of the province
821 encompasses the majority of the redwood forest habitat type. Inland forests are Douglas-fir and
822 mixed Douglas-fir/hardwood types, the latter often interspersed with chaparral and grasslands.”

823 Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) are
824 included in the California Coast Province, the Redwood Coast (RDC) and Interior Coast (ICC) regions. The
825 RDC is described below:

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826 “This region is characterized by low-lying terrain (0 to 900 m) with a maritime climate; generally
827 mesic conditions and moderate temperatures. Climatic conditions are rarely limiting to Spotted
828 Owls at all elevations. Forest communities are dominated by redwood, Douglas-fir-tanoak
829 forest, coast live oak, and tanoak series. The vast majority of the region is in private ownership,
830 dominated by a few large industrial timberland holdings. The results of numerous studies of
831 Spotted Owl habitat relationships suggest stump-sprouting and rapid growth rates of redwoods,
832 combined with high availability of woodrats in patchy, intensively-managed forests, enables
833 Spotted Owls to maintain high densities in a wide range of habitat conditions within the
834 Redwood zone. This modeling region contains the Green Diamond and Marin DSAs [density
835 study areas].” (USFWS 2011a, pg C-9 and C-10).

836 Along the coast of northwestern California young redwood and mixed conifer-hardwood stands appear
837 capable of supporting higher densities of Spotted Owls than younger forests in other regions. This is
838 particularly the case in areas where young hardwood forests provide a multilayered structure (Thomas
839 et al. 1990, Diller and Thome 1999) within a conifer stand. It is important to note here (and is discussed
840 later in the document) that density estimates are not necessarily linked with high quality habitat (i.e.
841 habitat conferring high reproductive success).

842 In young growth coastal forests with a negligible amount of old-growth stands (>200 yr) in Humboldt
843 and Del Norte counties, Thome et al. (1999) found Northern Spotted Owls were positively associated
844 with middle-aged stands (21-40 years-old) that contained larger trees and higher proportions of stands
845 with the largest basal area class (>69 m²/ha), and negatively associated with younger stands that
846 contained smaller trees. Irwin et al. (2013) found that Northern Spotted Owls used patches with more
847 large trees and greater basal area within two study areas in the coastal redwood zone (Fort Bragg and
848 Eureka). It is thought that stump-sprouting and rapid growth rates of redwoods, together with readily
849 available prey (mainly woodrats) and patchy intensively managed stands (e.g., small-patch clearcuts),
850 allows owls to occupy this habitat in higher densities (Thomas et al. 1990, USFWS 2011a). Thome et al.
851 (1999) found that timber management using clearcuts was associated with low reproduction, and
852 therefore recommended clearcuts be restricted to 1.1 km (0.68 mi) beyond the nest site.

Comment [DK29]: Citations to support this statement (??)

853 The ICC differs strikingly from the adjacent coastal redwood region, and is described below:

854 “This region... differs markedly from the adjacent redwood coast region. Marine air moderates
855 winter climate, but precipitation is limited by rain shadow effects from steep elevational
856 gradients (100 to 2,400 m.) along a series of north-south trending mountain ridges. Due to the
857 influence of the adjacent Central Valley, summer temperatures in the interior portions of this
858 region are among the highest within the Spotted Owl’s range. Forest communities tend to be
859 relatively dry mixed conifer, blue and Oregon white oak, and the Douglas-fir-tanoak series.
860 Spotted Owl habitat within this region is poorly known; there are no DSAs and few studies have
861 been conducted here. Spotted Owl habitat data obtained during this project suggests that some
862 Spotted Owls occupy steep canyons dominated by live oak and Douglas-fir; the distribution of
863 dense conifer habitats is limited to higher-elevations on the Mendocino National Forest.”
864 (USFWS 2011a, pg C-12, C-13)

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The southern limit of the owl's range in Marin County (part of the California Coast Province and inclusive of both RDC and ICC regions) contains coast redwood, Bishop pine (*Pinus muricata*) and Douglas-fir forests and mixed evergreen-deciduous hardwood forests (e.g., California bay, tanoak and coast live oak) which are regularly used by Spotted Owls (Jenson et al. 2006, USFWS 2011a). Stralberg et al. (2009) found that owls inhabiting Marin County mixed forests were equally likely to be found in conifer dominated stands as they were to be found in hardwood dominated stands, and were negatively affected by habitat fragmentation, yet there did not seem to be a preference for any one tree species when considering owl nest site occurrence. The higher densities of owls and high reproductive success in Marin County may be an indication of a more generalist nature of Marin owls when it comes to habitat selection and the high abundance of woodrats in this area, in contrast to other areas within the Northern Spotted Owl's range in California (Press et al. 2012). The higher use of nest platforms (rather than nest cavities) in the Marin County population is similar to the ratio seen in other younger aged forests, such as in the eastern Cascade Mountains in Washington (Jenson et al. 2006). LaHaye and Gutiérrez (1999) suggested nest type selection depends on the age of the forest, which is supported for the Marin County population where both logging and fire have resulted in younger-aged forests (Jenson et al. 2006).

California Klamath Province

A description of the California Klamath province is noted below, as defined in the 1992 Northern Spotted Owl recovery plan (USFWS 1992):

"The California Klamath province is between the California Coast province and the California Cascades province. It is a continuation of the Oregon Klamath province, south to the Clear Lake Basin in the inner Coast Range. The area is mountainous and covered primarily with Douglas-fir forests. Mixed Douglas-fir/pine forests are common at lower elevations with Douglas-fir/true fir forests at higher elevations."

Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) make up the majority of the California Klamath Province, the Western Klamath (KLW) and Eastern Klamath (KLE) regions. The ICC modeling region, which is described above, represents a relatively small southern portion of the California Klamath province. The KLW is described below:

"A long north-south trending system of mountains (particularly South Fork Mountain) creates a rain shadow effect that separates this region from more mesic conditions to the west. This region is characterized by very high climatic and vegetative diversity resulting from steep gradients of elevation, dissected topography, and the influence of marine air (relatively high potential precipitation). These conditions support a highly diverse mix of mesic forest communities such as Pacific Douglas-fir, Douglas-fir tanoak, and mixed evergreen forest interspersed with more xeric forest types. Overall, the distribution of tanoak is a dominant factor distinguishing the Western Klamath Region. Douglas-fir dwarf mistletoe is uncommon and seldom used for nesting platforms by Spotted Owls. The prey base of Spotted Owls within the Western Klamath is diverse, but dominated by woodrats and flying squirrels. This region

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903 contains the Willow Creek, Hoopa, and the western half of the Oregon Klamath DSAs.” (USFWS
904 2011a, pg C-12)

905 The KLE differs from K LW by the reduced influence of marine air and a slightly varying forest
906 composition. The KLE is described below:

907 “This region is characterized by a Mediterranean climate, greatly reduced influence of marine
908 air, and steep, dissected terrain. Franklin and Dyrness ([1973]) differentiate the mixed conifer
909 forest occurring on the “Cascade side of the Klamath from the more mesic mixed evergreen
910 forests on the western portion (Siskiyou Mountains), and Kuchler (1977) separates out the
911 eastern Klamath based on increased occurrence of ponderosa pine. The mixed
912 conifer/evergreen hardwood forest types typical of the Klamath region extend into the southern
913 Cascades in the vicinity of Roseburg and the North Umpqua River, where they grade into the
914 western hemlock forest typical of the Cascades. High summer temperatures and a mosaic of
915 open forest conditions and Oregon white oak woodlands act to influence Spotted Owl
916 distribution in this region. Spotted Owls occur at elevations up to 1768 m. Dwarf mistletoe
917 provides an important component of nesting habitat, enabling Spotted Owls to nest within
918 stands of relatively younger, small trees. The western half of the South Cascades DSA and the
919 eastern half of the Klamath DSA are located within this modeling region.” (USFWS 2011a, pg C-
920 12)

921 As mentioned above, Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) provides an important
922 component of nesting habitat, enabling Northern Spotted Owls to nest within stands of relatively
923 younger small trees (USFWS 2011a). Its distribution coincides with the distribution of Douglas-fir from
924 southern British Columbia to central Mexico (Hadfield et al. 2000).

925 The propensity for Northern Spotted Owls to utilize old structurally complex forests in the California
926 Klamath Province for nesting and roosting is supported by numerous studies on public and private
927 timberlands. Table 3 provides a detailed summary of habitat studies in the Klamath Province. Foraging
928 habitat may contain the typical older forest components of nesting and roosting habitat, but may also
929 include younger forests, hardwood stands, and more open areas (Solis and Gutiérrez 1990, Zabel et al.
930 1995, Irwin et al. 2012, Irwin et al. 2013).

931

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932 **Table 3.** Description of suitable habitat from studies of Northern Spotted Owl habitat relationships in the Klamath
933 Province (partially adapted from USFWS 2009, Table III.C.1).

Study	Location	Method	Description of Selected or Suitable Habitat
USFWS 1992, Bart 1995	Washington, Oregon, northern California	research synthesis (various methods)	conifer-dominated forest with a multi-layered canopy, average DBH1 >30 inches, >60% canopy cover, decadence (snags, logs, deformed trees)
Anthony and Wagner 1999	southwestern Oregon	aerial photographs, ground reconnaissance	conifer-dominated forest with a multi layered canopy, >40% canopy cover, decadence, large snags and logs; characterized by trees >30 inches DBH and >200 yrs
Blakesley et al. 1992	northwestern California	ground sampling, USFS timber stratum maps	coniferous forest characterized by trees >53.3 cm in diameter, forests at 300-900 m elevations for roosting, and the lower third of slopes within a specific drainage
Carey et al. 1992	southwestern Oregon	aerial photographs, forest inventory data, ground reconnaissance	multi-layered canopy, average DBH of dominant trees >39.4 inches, large snags and logs
Dugger et al. 2005	southwestern Oregon	aerial photographs, ground reconnaissance	conifer or mixed forest, >100 yrs; characterized by trees >13.8 inches DBH
Franklin et al. 2000	northwestern California	satellite imagery	forest comprised of >40% conifers, conifer QMD2 >21 inches, hardwood QMD >6 inches, canopy cover >70%
Gutiérrez et al. 1998	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Hunter et al. 1995	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Irwin et al. 2012	southwestern Oregon and northcentral California	ground sampling, modeling	Selection tied to increasing average diameter of coniferous trees and also with increasing basal area of Douglas-fir trees, increased with increasing basal areas of sugar pine hardwood trees and with increasing density of understory shrubs. Large-diameter trees (>66 cm) appeared important <400 m from nest sites.
Irwin et al. 2013	southwestern Oregon and northcentral California	forest inventory from private and federal landowners, modeling	Basal area (m ² /ha) between 35-60 in nesting period, and 30-54 in winter period, basal area of trees >66 cm was between 7-22 in nesting period, and 7-18 in winter period, QMD 37-60 in nesting period and 37-61 in winter period.
LaHaye and Gutiérrez1999	northwestern California	ground sampling	83% of nests located in Douglas-fir, 60% of nests located in brokentop trees, nest within forests characterized by large (> 90 cm dbh) conifers, a hardwood understory, and a variety of tree

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			sizes.
Meyer et al. 1998	western Oregon	aerial photographs	conifer-dominated forest, trees >80 yrs and/or multi-layered canopy
Ripple et al. 1997	southwestern Oregon	aerial photographs	conifer-dominated forest, average DBH >19.7 inches, canopy cover >60%
Solis and Gutiérrez 1990	northwestern California	timber type classification	average DBH >20.7 inches
Zabel et al. 1993	northwestern California	topographic maps, aerial photographs, and orthophotoquads	stands dominated (in terms of basal area) by trees >20.9 inches DBH; >20% canopy cover of dominant trees and >70% canopy cover of trees >5.1 inches DBH
Zabel et al. 2003	northwestern California	modified timber type classification, varied geographically	<u>nesting-roosting habitat</u> : for most locations average DBH >17 inches and average conifer canopy cover >60%; <u>foraging habitat</u> : in all locations average DBH >9.8 inches and average conifer canopy cover >40%, additional criteria in some locations

934

935 California Cascade Province

936 A description of the California Cascades province is noted below, as defined in the 1992 Northern
937 Spotted Owl recovery plan (USFWS 1992):

938 “The California Cascades province is bordered by the Oregon Cascades province, the Oregon and
939 California Klamath provinces, and the north end of the Sierra Nevada. It is the link between the
940 range of the northern Spotted Owl and the range of the California Spotted Owl. Suitable owl
941 habitat, which is fragmented on a broad scale by high- and low-elevation areas containing
942 marginal habitat, is predominately in two national forests. However, there are significant blocks
943 and checkerboard ownership areas where industrial private lands can provide suitable habitat.”

944 One modeling region described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) makes
945 up the majority of the California Cascades province, Eastern Cascade - South (ECS). The ICC modeling
946 region, which is described above, represents a relatively small southern portion of the California
947 Cascades province. The ECS is described below:

948 “Topography is gentler and less dissected than the glaciated northern section of the eastern
949 Cascades. A large expanse of recent volcanic soils (pumice region: Franklin and Dyrness [1973]),
950 large areas of lodgepole pine, and increasing presence of red fir and white fir (and decreasing
951 grand fir) along a south-trending gradient further supported separation of this region from the
952 northern portion of the eastern Cascades. This region is characterized by a continental climate
953 (cold, snowy winters and dry summers) and a high-frequency/low-mixed severity fire regime.
954 Ponderosa pine is a dominant forest type at mid-to lower elevations, with a narrow band of

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955 Douglas fir and white fir at middle elevations providing the majority of Spotted Owl habitat.
956 Dwarf mistletoe provides an important component of nesting habitat, enabling Spotted Owls to
957 nest within stands of relatively younger, smaller trees.” (USFWS 2011a, pg C-11, C-12)

958 Compared to other provinces in California, very little is known about the specific needs of the Northern
959 Spotted Owl in the California Cascades. In addition, no studies have been conducted to date evaluating
960 habitat quality (the amount and type of habitat most beneficial to owls) across owl sites in the California
961 Cascade Province. Recent telemetry work on foraging habitat use and selection has been conducted on
962 three large study areas at the interface of the southern Cascades and eastern Klamath Mountains in
963 southern Oregon and north-central California (Irwin et al. 2012, 2013). These studies provide valuable
964 information on foraging habitat use in the California Cascade region, but without demographic
965 performance information the results have limited utility for identifying the habitat’s quality for owls.

966 Irwin et al. (2012 and 2013) found that Northern Spotted Owls in Oregon and northwestern California
967 selected areas with greater density and basal area of trees >66 cm dbh (>26 dbh) within 400 m (0.25 mi)
968 of nest sites. The authors suggest a plausible optimal landscape for Spotted Owls in the region might
969 include stands of large-diameter trees near nest sites which are embedded in a heterogeneous forest
970 landscape of various selected foraging types. Modeling owl habitat based upon characteristics used
971 during nighttime foraging excursions, Irwin et al. (2012) found that owls selected mixed-aged and mixed
972 coniferous forest stands. In this study, the Yreka study site was inclusive of dry forest types on the
973 California Cascade Province.

974 In a modeling effort within the Klamath and Cascade provinces, habitat parameters were compared
975 among all forest types within the owls range in California, Oregon and Washington (considered habitat
976 across the entire range at the time) with that of California-specific knowledge of owl habitat within
977 Klamath and Cascade provinces (Zabel et al. 2003). These revised parameters considered new nesting,
978 roosting and foraging habitat types and attributes (e.g., younger trees, elevation, aspect, California-
979 specific soil classes) that the range-wide habitat map left out. The revised model performed better at
980 predicting owl occupancy in California’s interior forest types than the range-wide model. The study
981 concluded that modeling California habitat independent of range-wide habitat was more effective at
982 predicting owl occupancy and numbers in California interior forest types.

983 *Habitat Effects on Survival and Reproduction*

984 Habitat quality has been evaluated in a number of ways including: assessing density of owls in different
985 habitat types, comparing vital rates between owl sites with different habitat conditions, modeling vital
986 rates for populations of owls across broad areas that exhibit differences in landscape scale forest
987 composition, and modeling vital rates at individual owl territories with specific forest structure and
988 composition. The type, extent, and spatial configuration of forests in a high quality territory vary across
989 the range of the Northern Spotted Owl and across regions of California. Although many different
990 combinations of habitat can support a productive Northern Spotted Owl pair with high fitness, the body
991 of evidence suggests minimum thresholds for amounts and distributions of various forest types within
992 any given Northern Spotted Owl home range.

Comment [DK30]: I suggest calling this section: “Habitat effects on demographics” and include Survival, reproduction, occupancy rates and rate of population change (lambda) – see citations in Dugger et al. 2015 (as there are a ton....many relevant to southern distribution of NSO or the CA subspecies).

Comment [DK31]: Actually, coming up with specific thresholds that can be generalized across the species’ range has been really hard.....

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In the recent broad demographic analysis (Forsman et al. 2011), habitat variables were evaluated for effect on fecundity, survival, and rate of population change. Habitat data were not available for California, and so effect of habitat on demographic rates could only be evaluated for Oregon and Washington. In all Oregon study areas, modeling revealed strong evidence for an effect of suitable habitat on fecundity. Four of five Oregon study areas showed declines in fecundity with decreases in suitable habitat, however, the Klamath study area of southwest Oregon showed the opposite relationship, with fecundity declining with increases in suitable habitat. The latter result is consistent with one territory-based analyses in the Klamath province in California which showed an increase in fecundity with decreases in mature forest (Franklin et al. 2000), but is inconsistent with a territory-based analysis in the Klamath province of southern Oregon (Dugger et al. 2005). An additional study in southern Oregon, although not in the Klamath Province, also showed an increase in fecundity with decreases in mature forest (Olson et al. 2004).

There was weak evidence for a relationship between the percent cover of suitable habitat and apparent survival for four study areas in Oregon and Washington (Forsman et al. 2011). This is in contrast to three territory-based analyses in California and southern Oregon which found positive relationships between survival and mature forest (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). It is likely that habitat influences demographic rates of individual spotted owls on a home range or territory scale. Therefore where finer-scale data have been available, studies conducted at the scale of owl territories are more likely to detect an effect and are likely more representative of individual Spotted Owl habitat requirements than the broad meta-analysis.

Territory-based studies have revealed that owls occupy sites that vary in quality, with pairs exhibiting various levels of survival and productivity in association with habitat type. For example, Bart and Forsman (1992) found that Northern Spotted Owl productivity increased with increasing amount of older forests. Similarly, using turnover rates to define survival Bart and Ernst (1992) found that adults remained in a territory longer when mature and old-growth was present within the territory.

Certain habitat characteristics have been shown to support high quality Northern Spotted Owl territories, with both the amount and spatial configuration of different habitat types at a territory contributing to levels of survival and productivity in the resident owls. This measure of habitat quality at the scale of Northern Spotted Owl home range has been termed “habitat fitness potential” (HFP). HFP was defined by Franklin et al. (2000) as “...the fitness conferred on an individual occupying a territory of certain habitat characteristics.” and is determined by modeled values of lambda (λ ; defined as annual rate of population change²) and the rates of survival and reproduction that influence λ (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). The habitat characteristics that influence HFP include the amount of nesting, roosting, and foraging habitat, as well as the amount of non-habitat. The spatial configuration of these different habitat types around an activity center has also been shown to be

Comment [DK32]: See Dugger et al. 2015 for most recent analyses.

Comment [DK33]: I would refocus this discussion around more “edge” not less old forest, as that’s really more accurate across the range of studies you cite. Yes, Franklin et al. found a relationship between “less” interior old forest but also MORE edge, and in Olson et al. (2004) it was a relationship with Edge (positive, as in Franklin et al.). The contrary study, (Dugger et al. 2005) was also about EDGE, not a negative relationship with old forest. In other words, there has to be some minimum amount of old forest, and then more or less “edge” can have some impact.

Comment [DK34]: Turns out, this statement is actually wrong. I know this is what it says in the document, but this statement occurs in the rate of population change section of the Discussion, which was a “meta-analysis” of all study areas combined – so there should be no information on individual study area results here. I’m afraid this was a large typo that got missed in the production process. In fact, we found no evidence of a relationship between survival and habitat during the 2009 workshop – see Table 15, bottom of pg. 38 – left column for meta-analysis of survival and Tables 20, 21 and bottom of pg. 52 for survival in meta-analysis of lambda – in both cases, no evidence of relationship with habitat.

However!!! See Dugger et al. (2015) for most recent meta-analysis – we did find relationships between survival and habitat (positive usually) on some study areas. Edge too, but be careful with the edge covariate – it was developed differently than has been done in other studies, so it was highly correlated with amount of suitable habitat and behaved contrary to predictions.

Also see Wiens et al. 2014 – telemetry study that links NSO survival to older forest habitat.

Comment [DK35]: See several papers out now linking occupancy dynamics (extinction and colonization rates) to habitat – particularly Dugger et al. 2011, 2015, Yackulic et al. 2012, 2014,

² See section on Demographic Rates below for a discussion of lambda and fitness.

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important in determining HFP. Studies that have evaluated HFP vary somewhat in the size of core areas evaluated and some have evaluated a broader area representing the broader home range. Studies have occurred in southwestern Oregon and northwestern California and so represent different geographic areas and forest types, although most are largely in the Klamath Province of Oregon and California. Three territory-based studies at study areas in the interior of California and southern Oregon have found fairly strong associations between habitat characteristics and demographic rates of northern spotted owls (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). These studies are summarized below and in Table 4.

Each of the three studies attempted to evaluate the effect that older forests (representing nesting/roosting habitat) and other habitat components have on owl demographic rates. In all cases the authors have attempted to capture habitat composed of the oldest forests in the study area to represent high quality nesting and roosting habitat, based on the strong association of the Northern Spotted Owl with mature and old-growth forests. Availability of data for each study area resulted in different definitions of nesting and roosting habitat in each study. Depending on the study, additional attributes evaluated included nonhabitat (e.g., nonforested areas) and amount of edge between various land cover types.

Franklin et al. (2000) modeled the relationship between owl habitat covariates in the core area of Spotted Owl home ranges and Northern Spotted Owl fitness in portions of the north Coast Range and the Klamath Mountains in California. In this study, Northern Spotted Owl habitat was defined as “mature and old-growth forest with a quadratic mean diameter of ≥ 53 cm, quadratic mean diameter of hardwoods ≥ 15 cm, percentage of conifers $\geq 40\%$, and overstory canopy coverage of $\geq 70\%$.” Apparent survival increased with an increased amount of owl habitat, with the amount of edge between owl habitat and other habitat, and at intermediate distances between patches and owl habitat. There was a rapid decrease in survival when the amount of owl habitat fell below about 100 acres (40 hectares) of owl habitat within the core use area. Reproductive rate also increased with an increase of edge between owl habitat and other habitat types, but decreased with increasing amount of owl habitat. Reproductive output had a non-linear relationship with amount of owl habitat, only increasing substantially when the amount of owl habitat was less than 75 to 100 acres (30 to 40 hectares). Variation in survival was attributed mostly to habitat, whereas variation in reproductive output was attributed to both to habitat and climatic events (e.g., cold heavy rains during peak breeding season). HFP was maximized in sites with sufficient owl habitat to facilitate high survival and sufficient edge to facilitate both high survival and high reproductive output. Given this, the authors suggest that there is a trade-off between the amount of owl habitat and edge required to maximize survival and reproduction, while at the same time noting that the components of quality edge habitat are still poorly understood since the study did not discriminate between types or amount of “other habitat”. Despite the trade-off between survival and reproduction, estimates of λ have been shown to be driven by survival rates in Northern Spotted Owls (Forsman et al. 2011), and “...low amounts of spotted owl habitat within a territory will not supply the high degree of edge predicted to support high reproductive output” (Franklin et al. 2000).

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1067 **Table 4.** Comparison of three territory-based demographic studies in the interior of California and southern
1068 Oregon.

	Franklin et al. 2000	Olson et al. 2004	Dugger et al. 2005
Definition of older forest evaluated in the study (representing nesting/roosting habitat)	Spotted owl habitat = mature and old-growth forest with QMD of conifers >53 cm (~21 in), QMD of hardwoods >15 cm (~6 in), percentage of conifers >40%, and overstory canopy coverage >70%	<u>Late-seral forest</u> = stands characterized by trees with >80 cm (~31.5 in) dbh; generally associated with high quality nesting, roosting, and foraging habitat. <u>Mid-seral forest</u> = stands characterized by trees with 24-80 cm (9.5 - 31.5 in) dbh.	<u>Old forest</u> = older (>100 years) conifer or mixed stands characterized by canopy cover >40% and trees >35cm (~14 in) dbh. <u>Old growth</u> = old (>200 years) conifer-dominated stands characterized by canopy cover >40% and trees >75 cm (~29.5 in) dbh.
Relationship between older forest and <u>survival</u>	Positive Survival declined rapidly at sites with less than ~100 acres of spotted owl habitat in the core area (i.e. <25%) Core area = 390 acres	Positive In general, late-seral forest had a positive effect on survival. However, the best model showed highest survival when combined mid- and late-seral forest was about 70% of the 1,747 acre (1,500-m radius) circle	Positive Pseudothreshold relationship with survival rate dropping rapidly when proportion of old forest in the core drops below ~20-30% (~80-100 acres) Core area = ~413 acres
Relationship between older forest and <u>productivity</u>	Negative Nonlinear relationship with reproductive output increasing when amount of older forest in the core area is less than ~75-100 acres	Negative Productivity declined with increases in mid- and late-seral forest	Positive Linear effect with old growth forest in the core area providing the best model
Amount of older forest in the core area for high fitness territories^a	Variable, with an apparent trade-off between providing sufficient older forest to support survival and provide a high amount of edge, while limiting portion of core area in older forest in order to support high productivity (see Fig 10 in Franklin et al.; generally at least ~25% older forest required in core to support high fitness)	N/A The best model included only the 1,500m diameter circle (~1,747 acres representing broader home range)	In general, territories with <40% of the 413 acre core (~165 acres) composed of older forests had habitat fitness potential <1.0
Effect of habitat in broader home range or 'outer ring' on vital rates^b	N/A	Territories with high estimates for λ had a high amount of mid- and late-seral forest in the 1,747 acre area, but also have patches of nonforest within the mosaic of forest types	Survival declined when the amount of nonhabitat in the outer ring portion of the home range exceeded about 60%.
Relationship of vital rates with the amount of non-habitat (non-forest areas, sapling stands, etc.)	Did not evaluate ^c	Increases in early seral and nonforest had a negative effect on survival	Survival decreased dramatically when the amount of non-habitat exceeded ~50% of the home range

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Relationship of vital rates with amount of edge between older forest and other vegetation types^d	Both apparent survival and reproductive output increased with increasing edge between spotted owl habitat and other vegetation types ^e	The best model showed a positive relationship between productivity and amount of edge between mid- and late-seral forest and the other types (early-seral and nonforest).	No support for either a positive or negative effect on survival or reproductive rate
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^aSize of the core area evaluated varies across studies. Franklin et al. (2000) evaluated a 390 acre core area. Olson et al. (2004) evaluated a ~279 acre core area, but their best model included only the 1,500m diameter circle (~1,747 acres). Dugger et al. (2005) evaluated a ~413 acre core area.

^bSize of the broader home range or 'outer ring' evaluated varies across studies. Franklin et al. (2000) did not include an outer ring of habitat or broader home range in their modeling. Dugger et al. (2005) evaluated a ~3,455 acre outer ring. In addition to the core area, Olson et al. (2004) evaluated two larger circles of habitat of ~1,747 and ~4,473 acres.

^cFranklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types.

^dEdge is defined differently among the studies. Franklin et al. (2000) defined edge as occurring between mature forest (spotted owl habitat) and all other vegetation types. Olson et al. (2004) and Dugger et al. (2005) define edge as occurring between nonhabitat and all intermediate and mature forest types.

^eFranklin et al. (2000) were unable to distinguish different types of edge, but suggested that edges between spotted owl habitat and clearcuts do not generate the type of mosaic that was observed in high-fitness territories.

In their Oregon coast study area, Olson et al. (2004) analyzed various forest types: late-seral, mid-seral (broken further into conifer and broadleaf), and non-forest, within 600, 1,500 and 2,400 m radius around Northern Spotted Owl site centers. The best model indicated survival was highest when the amount of mid- and late-seral forest was about 70% within the 1,500 m (0.9 mi) radius circle, and survival decreased when the amount of mid- and late-seral forest increased above about 85% or declined below about 50%. Increases in early seral or non-forest had a negative effect on survival. The best model indicated reproductive rates were positively correlated to the amount of edge between mid-seral and late-seral forest and other forest types (early-seral or non-forest), and suggested a high amount of mid- and late-seral forest in the 1,747 acre area with patches of nonforest within the mosaic of forest types provided high fitness.

In an Oregon study (including portions of the western Cascades and eastern Siskiyou Mountains, both comparable to areas in California), Dugger et al. (2005) found the best models contained a positive linear effect of older forest types in the core area (defined as 413 acres) on reproductive rate, with the best model including old-growth. There was strong evidence to support a positive relationship between amount of older forest types in the core area, and an increase in apparent survival. Dugger et al. (2005) found little to no effect on survival and reproduction rate for intermediate-aged forests, defined as forests between sapling and mature stages with total canopy cover over 40%. The study also analyzed habitat within a broader area around the core area, representing an outer ring of the home range (3,455 acres outside of the core area). Within the broader area, survival declined when the amount of non-habitat, defined as non-forest and early seral stages including sapling stage, within the ring outside the core area exceeded 60%. Survival estimates were highest when the amount of non-habitat fell between roughly 20 to 60% in the broader portion of the home range, and survival estimates were lower as non-habitat fell below 20% or above 60%. Modeling efforts did not find any direct effect of edge, although edge was defined differently than in the Franklin et al. (2000) study. Although Dugger et al. (2005) did

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1106 not find any evidence that a mosaic of old forest intermixed with forests of intermediate age (with
1107 hardwood component) provided benefit to the Northern Spotted Owl, nor a benefit of edge, the
1108 negative quadratic relationship between owl survival and amount of non-habitat in the broader portion
1109 of the home range may suggest some benefit of an intermediate amount of “edge” in this larger area.
1110 The study concludes, “in general, territories with <40% old forest or old-growth habitat near the site
1111 center had habitat fitness potential <1, consistent with the relationships between both reproduction
1112 and survival and the amount of old forest habitat at the core.”

1113 All three of the above studies found a positive relationship between the amount of late-seral forest and
1114 survival, with two (Franklin et al. 2000, Dugger et al. 2005) showing a rapid decline in survival when the
1115 amount of late-seral forest in the core area dropped below about 25% (i.e., about 100 acres of late-seral
1116 forest is required in the 400 acre core to support survival). The third study (Olson et al. 2004) found that
1117 declines in survival accelerated when the amount of mid- and late-seral forest in a larger area (~1,750
1118 acre) declined below 50%, with highest survival at 70% mid- and late-seral forest. Two of the three
1119 studies found a negative relationship between the amount of older forest and productivity in the core
1120 area (Franklin et al. 2000) or in the broader home range (Olson et al. 2004); this shows an apparent
1121 trade-off between providing sufficient older forest to support survival, while limiting the amount of
1122 older forest in order to support high productivity. The third study found a positive relationship between
1123 older forest in the core area and productivity (Dugger et al. 2005).

1124 Dugger et al. (2005) found that territories required that about 40% of the core area be composed of
1125 older forests in order for HFP to be greater than 1.0. The results of Franklin et al. (2000) suggest that
1126 about 25% of the core area must be in older forest to support high fitness. The two studies that
1127 evaluated a broader home range found that the amount of non-forested area and other forms of
1128 nonhabitat must be limited in order to support high HFP (Olson et al. 2004, Dugger et al. 2005). Olson et
1129 al. (2004) and Dugger et al. (2005) both found that survival decreased dramatically when the amount of
1130 early seral forest or other non-habitat exceeded ~50% of the home range.

1131 In their coastal study area within California’s Humboldt and Del Norte counties, Thome et al. (1999)
1132 showed that reproductive rate was inversely related to age class and basal area age classes within
1133 forests managed with clear-cut silviculture practices. Specifically, sites with high proportions of 21-40
1134 year-old stands, lower proportions of 61-80 year-old stands and the largest basal area class (>69 m²/ha)
1135 had higher reproduction; however sites with higher reproduction also had more residual trees at 50
1136 hectare circle (0.149 trees/ha) and 114 hectare circle (0.201 trees/ha) surrounding owl sites. The
1137 explanation was presumed to be related to the larger abundance of preferred prey (i.e., woodrats)
1138 among younger forests coupled with the limited availability of older forests on the study area. The
1139 authors concluded that 21-40 year-old stands were young enough to contain sufficient amounts of prey
1140 during foraging, yet old enough to provide structural for roosting, nesting, and maneuverability, such as
1141 high canopy and large residual trees.

1142 It is important to note that the relationships found between owl fitness and habitat in the studies
1143 described above apply only to areas with similar conditions as those analyzed as part of the studies, and
1144 findings may not be applicable to owl territories throughout the owl’s entire range in California. For

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example, the study area described in Olson et al. (2005) comprised different forest types than those described in Dugger et al. (2005) or Franklin et al. (2000) and where the primary food source was flying squirrels rather than woodrats.

Overall, Northern Spotted Owls require some minimum level of old forest, including old-growth, within their core range and broader range to optimize survival and productivity. It is also apparent that older forest mixed with other forest types (excluding non-habitat) benefits Northern Spotted Owl fitness, at least partially due to the increased foraging opportunities along transitional edges. This effect may be more prevalent in the interior zones of California and southern Oregon, (Klamath and Cascade provinces) where owl habitat differs significantly than coastal or more northern portions of the range. In spite of uncertainties around which level of old forest and edge attains the best fitness for owls, the literature points to the benefits of a mosaic of forest types that contain sufficient older forest, especially around the core area, while limiting the amount of nonhabitat in the home range. Based on the studies in the interior of the species' range in California and southern Oregon, management that maximizes late-seral forest in the core area (at least 25-40%) while limiting the amount of nonforest or sapling cover types throughout the home range (no more than about 50%) would likely result in high quality Spotted Owl territories.

Comment [A36]: Note to external reviewers:
Prior to final draft, we will consider adding Figure 6 from Dugger et al. (2005) or Figure 10 from Franklin et al. (2000) to illustrate the amounts and configuration of various habitat types in high quality territories.

Comment [DK37]: Be careful with HFP – Alan Franklin developed this metric as theoretical construct to envision how different amounts and configurations of habitat can affect vital rates differently, and therefore “interact” to produce varying levels of “quality” associated with forested landscapes for NSO. I think you have this sentence largely correct, just be careful not to be too prescriptive or specific about what constitutes required specific amounts of each habitat type – we have some common generalities.....40-60% old forest at “the core” (area around the nest or activity center however that’s defined....) seems important, but beyond that you can’t say too much. I’d recommend having Alan read this section before you finalize the document.

Comment [DK38]: See my comments above about density.

Comment [DK39]: This one is CA Owl, but provides strongest evidence of this breeding effect.

Status and Trends in California

Abundance

No range-wide estimate for abundance of Northern Spotted Owl exists because survey methods and effort conducted to date do not provide for reliable estimation of population size across the species' range (USFWS 2011a). Few areas across Washington, Oregon and California ~~the range~~ have been sufficiently sampled to accurately estimate densities of Northern Spotted Owls (Franklin et al. 1990, Tanner and Gutiérrez 1995, Diller and Thome 1999). As mentioned above, Northern Spotted Owl densities vary across the range and forest types and so extrapolating the few local estimates across the range of the subspecies would result in biased estimates of abundance (See Life History section of this report for detailed information in density estimates in California). Because Northern Spotted Owls have large home ranges it is necessary to systematically survey very large areas in order to obtain reliable estimates of density (Franklin et al. 1990). In addition, detection rates of spotted owls during nighttime call surveys are vary widely, but are generally <1.0 (Olson et al. 2005, Anthony et al. 2006, Kroll et al. 2010, Forsman et al. 2011, Dugger et al. 2009, 2011). Current survey techniques do not effectively sample nonterritorial individuals (floaters), and may vary for territorial birds relative to whether they are breeding or not in any given year (Anthony et al. 2006, Forsman et al. 2011, Stoelting et al. 2015). Finally, the presence of barred owls in the landscape can decrease the detection rates of spotted owls, in some cases, very dramatically (Olson et al. 2005, Crozier et al. 2006, Kroll et al. 2010, Wiens et al. 2010, Dugger et al. 2009, 2011). Thus, wWithout an effective sampling method that addresses the inability to detect all owls in a given area, it is not possible to provide an accurate estimate of abundance. Diller and Thome (1999) suggested that unless most individuals in a population are marked, density estimates would be biased. Studies that have provided density estimates have applied

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only to territorial owls (Diller and Thome 1999). Surveys do not effectively sample nonterritorial individuals (floaters); therefore, little is known about the floater population of owls other than they exist and that they generally do not respond to broadcast surveys. This leads to an issue of detectability that is difficult to overcome in estimating density or abundance of Northern Spotted Owls in a given area. Without an effective sampling method that addresses the ability to detect all owls in a given area, it is not possible to provide an accurate estimate of abundance. See the discussion on occupancy in the Demographic Rates section of this report for potential effects of floater owls on occupancy rates at known owl sites.

An early report out of the California Forestry Association (Taylor 1993) attempted to derive a population estimate for the Klamath Province in California. However, many assumptions were required in the analysis process, especially in developing estimates for amount of suitable habitat on federal and private land, estimating the fraction of land that had previously been surveyed, and estimating the proportion of sites that are occupied. In addition, no criteria were mentioned for what constituted “suitable” habitat, although 100% of forested land not owned by the USFS was considered to be suitable. The paper acknowledges that several of the assumptions made in deriving the population estimate are untested and that high levels of uncertainty exist in many of the estimates. Taylor (1993) partitioned land into ownership type, estimated the amount of suitable habitat on each type, estimated the fraction of land surveyed on each type, used the number of activity centers in the Department database and the estimates for fraction of suitable habitat surveyed to obtain an estimate of total sites in each type, and used an average occupancy rate from a subset of sites to extrapolate occupancy across the entire province. Estimates for suitable habitat and the percentages of suitable land surveyed for owls were derived from telephone interviews with landowners, timber company GIS layers and Timber Harvest Plan (THP) data, and a U.S. Forest Service report for National Forests. Due to the many untested assumptions and high amount of uncertainty in estimates, and the vague description of methods used, the report cannot be considered to provide a valid population estimate for the Klamath Province.

A recent study made use of the immense amount of data available on Northern Spotted Owl habitat requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity, dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the range of the owl (Schumaker et al. 2014). In addition to an evaluation of source-sink dynamics, outcomes of the model included a range-wide population size estimate, and the proportion of the population in each modeling region and physiographic province noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). Estimates of [population size by geographic region](#) ~~at~~ ~~population sizes~~ indicate that Northern Spotted Owls are most abundant in parts of southern Oregon and northern California (Table 5). The three California provinces were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population. The model indicated that the Klamath region is a stronghold for the population, with 50.1 percent cumulatively within the Oregon Klamath and California Klamath provinces, and 37.1 percent within the Klamath East and Klamath West modeling regions. Schumaker et al. (2014) estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions. Although informed by the best available data to develop an

Comment [DK40]: I would suggest deleting this entire discussion. At best it’s “dated” information, and at worst – as noted in the last sentence, due to methodological issues, etc., it’s not useful information.

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1223 impressive assessment of source-sink dynamics across the range, the complexity of the model may limit
1224 its ability to accurately model population estimates. For example, differences in the simulated number
1225 of owls versus the numbers observed in eight demographic study areas used for calibration ranged from
1226 5 to 47 percent (Schumaker et al. 2014). Nevertheless, the results suggest that California’s population of
1227 Northern Spotted Owls is an important component of the range-wide population.

1228

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1229 **Table 5.** Percent of range-wide Northern Spotted Owl population within modeling region and physiographic
1230 province (adapted from Table 2 in Schumaker et al. 2014).

Modeling Region	Percent of Population	Physiographic Province	Percent of Population
North Coast Olympics	0.1	Washington Western Cascades	1.3
West Cascades North	0.1	Washington Eastern Cascades	1.6
East Cascades North	3.3	Washington Olympic Peninsula	>0.0
West Cascades Central	1.2	Washington Western Lowland	>0.0
Oregon Coast	1.0	Oregon Eastern Cascades	3.5
West Cascades South	15.3	Oregon Western Cascades	23.3
Klamath West	20.0	Oregon Coast	0.8
Klamath East	17.1	Oregon Willamette Valley	>0.0
Redwood Coast	16.4	Oregon Klamath	13.7
East Cascade South	3.8	California Coast	16.6
Inner California Coast	21.7	California Cascades	2.8
		California Klamath	36.4

1231

1232 Most surveys for Northern Spotted Owls have been conducted on areas proposed for timber
1233 management activities in order to assess the potential for impacting the species, or on demographic
1234 study areas where long-term research is conducted throughout the subspecies range. Although not
1235 designed for estimating density or abundance, pre-harvest surveys have dramatically increased
1236 knowledge on location of territorial owl sites (i.e., activity centers). As survey effort has expanded to
1237 new areas over time, the number of known activity centers has naturally increased. Although owls will
1238 shift activity centers over time, they exhibit high site fidelity to general nesting and roosting areas
1239 (Gutiérrez et al. 1995, Blakesley et al. 2006), therefore the increase in number of activity centers over
1240 time is more likely a result of expanded survey effort than establishment of new activity centers. In
1241 addition, across most of the Northern Spotted Owl range establishment of new nesting and roosting
1242 habitat that is suitable for supporting an activity center is a slow process given tree species growth rate,
1243 and so a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.
1244 The possible exception to this is on the redwood coast where Northern Spotted Owls have been shown
1245 to select relatively young forests (41-60 years old) for nesting and roosting, as long as all habitat
1246 requirements are present (Thome et al. 1999). For example, Green Diamond Resource Company has
1247 reported the addition of 58 new sites since 1994 in a portion of their property that is completely
1248 surveyed each year and attributes this at least in part to improving habitat conditions as forests mature
1249 (GDRC 2015). The number of newly established activity centers across the range as a result of newly
1250 available nesting and roosting habitat is unknown. See the discussion on habitat changes in the threats
1251 section for additional information on the topic of habitat recruitment. The Humboldt Redwood
1252 Company has also reported an increase in number of sites since 2008 (HRC 2015). A concurrent increase
1253 in detections of Barred Owls in heavily surveyed areas suggests that the increase in Spotted Owl activity
1254 centers is likely due at least in part to increased survey effort (see Figure 28 in the Threats section of this
1255 report). However, it is possible that the increase in Spotted Owl activity centers is due to the movement
1256 of Spotted Owls as a result of displacement by an increasing number of Barred Owls (HRC 2015) or
1257 displacement from lands that are no longer suitable due to timber harvest or wildfire.

Comment [DK41]: Did you “define” this term earlier? If not, need some explanation here.

Comment [DK42]: See Davis et al. 2011 and 2015 – there is essentially very little “new” NSO habitat, and in fact suitable habitat is still declining.

Comment [DK43]: Yes, see Davis et al. 2011, 2015

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In California, the number of known Northern Spotted Owl activity centers rapidly increased starting around 1990 when listing under the federal Endangered Species Act resulted in a widespread increase in survey effort (Figure 3). Through 1989, there were 1,366 Northern Spotted Owl activity centers in California. By the year 1999, this number had increased to 2,799. As of 2014, the number of Northern Spotted Owl activity centers was 3,116. The number of occupied activity centers in any given year is unknown because not all areas have been or can be surveyed on an annual basis (USFWS 2011a). It is likely that many of the known sites are unoccupied because of habitat loss due to timber harvest or severe fires, displacement by Barred Owls, or other factors, therefore much of the data from early survey reports are outdated and of little use in addressing population abundance or distribution questions (Courtney et al. 2004). For these reasons and for the sampling reasons discussed above, the number of activity centers does not represent an index of abundance but rather the cumulative number of territories recorded (USFWS 2011a).

Demographic Rates

Comment [DK44]: See Dugger et al. (in press).

“Because the existing survey coverage and effort are insufficient to produce reliable range-wide estimates of population size, demographic data are used to evaluate trends in Spotted Owl populations” – USFWS (2011a).

The U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) initiated eight long-term demography studies within the range of the Northern Spotted Owl during the years 1985 to 1991 in order to provide data on the status and trends of Spotted Owl populations, and to inform the effectiveness of the NWFP on federal lands (Lint et al. 1999). Additional demographic study areas that were not established under the NWFP ~~have also been initiated~~ were also initiated in the late 1980’s and early 1990’s. The additional study areas that are currently active include one entirely on private land (i.e., Green Diamond Resource Company), one on the Hoopa Indian Reservation land, and one composed of a mix of federal, private, and state lands (i.e., Rainer). The study areas range between Washington and northern California, and collectively represent about 9% of the range of the Northern Spotted Owl (Forsman et al. 2011; Figure 7).

These eleven study areas have been monitored annually since inception with an average of 19 survey years across all areas (Table 6). On each study area, territorial owls are captured and banded, followed by annual attempts to recapture or resight owls and to evaluate reproductive success of territorial pairs. Standard protocols ensure consistent and thorough attempts to band and resight territorial owls and to assess nesting status of territorial females (Anthony et al. 2006). Over the period of 17-24 years (depending on study area), a total of 5,224 non-juvenile owls have been marked in the eleven study areas with a total of 24,408 annual captures/recaptures/resightings, allowing for robust estimates of survival. The number of young produced by territorial females was determined in 11,450 separate cases (Forsman et al. 2011). Three study areas are located in California, representing a diverse land ownership; the Northwest California study area (NWC) is primarily on federal land, the Green Diamond Resource Company study area (GDR) is on private land, and the Hoopa Indian Reservation study area (HUP) is on tribal land. These three study areas cover approximately 6% of the range of the Northern Spotted Owl in California (based on the USFWS range). The GDR study area is entirely within the California Coast

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Province, the HUP study area is located on the western edge of the California Klamath Province, and the NWC study area is mostly in the Klamath Province with a small portion in the Coast Province. There is no demographic study area in the California Cascades Province.

Table 6. Descriptions of 11 demographic study areas used to assess vital rates and population trends through 2008. Adapted from Table 1 and Appendix A in Forsman et al. (2011).

Study Area	Acronym	Years	Area (km ²)	Ownership
<i>Washington</i>				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
<i>Oregon</i>				
Coast Ranges*	COA	1990-2008	3,922	Mixed
H.J. Andrews*	HJA	1988-2008	1,604	Federal
Tyee*	TYE	1990-2008	1,026	Mixed
Klamath*	KLA	1990-2008	1,422	Mixed
South Cascades*	CAS	1991-2008	3,377	Federal
<i>California</i>				
NW California*	NWC	1985-2008	460	Federal
Hoopa Tribe	HUP	1992-2008	356	Tribal
Green Diamond	GDR	1990-2008	1,465	Private

*Indicates the eight study areas that are part of the federal monitoring program for the northern spotted owl.

Data from the demographic study areas have been compiled and analyzed regularly, with the most recent analysis covering all survey years through 2008 (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011). Demographic rates are estimated for each study area, and for all study areas combined (meta-analysis). An additional meta-analysis of data from the demographic study areas is ongoing and will include data through 2013. This additional information should provide further insight into important demographic rates across the species range. As discussed above, data collected from existing surveys are not sufficient to estimate population sizes, and so population trends cannot be assessed by comparing estimates of population size over time. However, the consistent collection of large amounts of capture/recapture data and observations of reproductive effort has resulted in an enormous amount of information which allows for estimation of vital rates across much of the range of the Northern Spotted Owl. When sufficient data is available, examination of demographic trends in survival and reproduction is one of the most reliable methods of assessing the health of a population. These data also allow for estimation of the annual rate of population change, lambda (λ), which reflects changes in population size resulting from reproduction, mortality, and movement into and out of a study area. Lambda does not provide a numerical estimate of population size, but instead estimates the proportional change in a population over a set period of time.

In addition to the coordinated analysis of data from all demographic study areas that occurs every 5 years, reports are available from individual study areas. Results from these reports are included in the

Comment [A45]: Note to external reviewers:
Where more recent data on demographic rates are available, either through annual reports or through presentations that have been publicly available, we include results as appropriate. We will update this report to include full results of the ongoing meta-analysis if the full publication becomes available prior to finalizing this status review.

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1321 discussion below when they offer more current information on the three California study areas than the
1322 most recent coordinated meta-analysis of 2011.

1323 *Rate of Population Change*

Comment [DK46]: See Dugger et al. 2015.

1324 A primary goal of the large scale monitoring at the demographic study areas and the regular coordinated
1325 analysis of data is to monitor population trends of the Northern Spotted Owl through estimation of
1326 lambda (λ , defined as annual finite rate of population change) (Anthony et al. 2006, Forsman et al.
1327 2011). A λ of 1.0 indicates that a population is stationary, whereas values greater or less than 1.0
1328 indicate increasing or declining populations, respectively. The most recent meta-analysis for all eleven
1329 study areas produced a weighted mean λ of 0.971 (standard error = 0.007, 95% confidence interval =
1330 0.960 to 0.983), corresponding to an average rate of population decline of 2.9% per year from 1985 to
1331 2006 (Forsman et al. 2011). Estimates of λ were below 1.0 for all 11 individual study areas, and ranged
1332 from 0.929 to 0.996 (Table 7). Population declines were most pronounced in Washington and the Coast
1333 Ranges of Oregon. The 95% confidence intervals do not overlap 1.0 for seven of the study areas,
1334 indicating strong evidence for population decline on these seven study areas. Although this study area-
1335 level demographic analysis did not show evidence for declines at KLA and CAS study areas, a territory-
1336 based study conducted in the Klamath Mountains and Cascade Range of southwest Oregon showed
1337 evidence for declining populations by 1996 (Dugger et al. 2005). In California, populations at GDR and
1338 NWC have declined, with estimates of λ of 0.972 for GDR (2.8% decline per year) and 0.983 for NWC
1339 (1.7% decline per year).

1340 In a more recent analysis of the available data, Franklin et al. (2015) reported a λ of 0.976 (1985-2013;
1341 95% CI 0.953-0.998) for the Willow Creek Study Area (part of the NWC study area). This shows an
1342 accelerated rate of decline (2.4% decline per year) compared to that reported by Forsman et al. (2011)
1343 for NWC. As reported in Forsman et al. (2011), the 95% confidence interval for HUP overlapped 1.0, so
1344 the study could not conclude that this population was declining through 2008. However, Higley and
1345 Mendia (2013) reported a λ of 0.977 (1985-2012; SE = 0.01; 95% CI 0.958-0.996) equating to a 2.3%
1346 population decline per year through 2012. This is the first time that the 95% CI for HUP does not include
1347 1.0, providing strong evidence that all three study areas in California now have declining populations of
1348 owls.

1349

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Table 7. Demographic parameters for the Northern Spotted Owl demographic study areas through the year 2008. Adapted from Table 22 in Forsman et al. (2011) and Table A-1 in USFWS (2011).

Study Area	Fecundity	Apparent Survival ¹	Lambda (λ)	Population Change ²
<i>Washington</i>				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
<i>Oregon</i>				
Coast Ranges	Increasing	Declining	0.966	Declining
H.J. Andrews	Increasing	Declining	0.977	Declining
Tyee	Stable	Declining	0.996	Stationary
Klamath	Declining	Stable	0.990	Stationary
South Cascades	Declining	Declining	0.982	Stationary
<i>California</i>				
NW California	Declining	Declining	0.983	Declining
Hoopa	Stable	Declining	0.989	Stationary
Green Diamond	Declining	Declining	0.972	Declining

¹ Apparent survival calculations are based on model average.

² Population trends are based on estimates of realized population change.

Conversion of estimates for λ to estimates of realized population change (i.e., the proportional change in estimated population size relative to population size in the initial year of analysis) revealed dramatic declines in regional population sizes (Forsman et al. 2011). The study areas in the northern portion of the range showed precipitous declines, with populations in the Olympic, Cle Elum, and Rainier study areas in Washington and the Coast Range study area in Oregon estimated to have declined by 40 to 60% during the study period (Forsman et al. 2011). At a rate of decline of 2.9% per year, the total population of Northern Spotted Owls across all study areas would have declined by nearly 50% over the 22 years included in the study. Although the 95% confidence intervals for estimates of realized population change slightly overlapped zero, two study areas in California (NWC and GDR) showed estimated population declines of about 20% during the period of study. Using the revised estimate of λ for NWC through year 2013 (Franklin et al. 2015) would result in a larger estimated population decline for NWC. The other study area in California (HUP), showed a slight decline in population size at the end of the study period in 2008, but the 95% confidence interval broadly overlapped zero. Again, using more recent data such as those reported by Higley and Mendia (2013) would provide stronger evidence for a population decline at HUP.

Although the meta-analysis assessing vital rates on all demographic study areas through 2013 is ongoing, preliminary meetings held to coordinate data compilation and analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; the average rate of population decline per year on the eleven demographic study areas has been 3.8% per year (Dugger et al. in review, Higley and Mendia 2013), compared to a decline of 2.9% per year using data

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1375 through 2008 (Forsman et al. 2011). The ongoing analysis has revealed large changes becoming
1376 apparent in Oregon and California, with Northern Spotted Owl populations in California declining by 32-
1377 55% over the study period (1985-2013; Dugger et al. [in review](#)).

Comment [DK47]: In press! (finally)

1378 *Fecundity and Survival*

Comment [DK48]: See Dugger et al. 2015

1379 Fecundity (i.e., number of female young produced per adult female) and survival rates are estimated in
1380 order to inform estimates of λ , to determine the degree to which changes in these vital rates effect
1381 populations, and to model effect of potential explanatory variables on these important vital rates. The
1382 Northern Spotted Owl is a long-lived species, with relatively high adult survival rates, and with high
1383 variability in fecundity from year to year. Fecundity estimates varied across study areas and ranged from
1384 0.230 to 0.553 female young produced per adult female (Forsman et al. 2011). Most Spotted Owls do
1385 not breed every year, but more normally breed every other year, which contributes to low fecundity in
1386 the species. There was evidence for declining fecundity on five areas, three areas were stable, and three
1387 areas showed increasing fecundity (Forsman et al. 2011). In California, fecundity showed declines on
1388 two areas (NWC and GDR) and was stable on one area (HUP), although HUP exhibited the lowest
1389 fecundity rate of all eleven study areas. Adult survival has declined on 10 of 11 study areas, with the
1390 Klamath study area in Oregon being the exception. Annual survival rate represents the probability that a
1391 bird that was alive in one year will be alive the following year, therefore a mean rate of 1.0 would
1392 indicate that all birds survive from one year to the next. Values of mean apparent adult survival for the
1393 entire study period range from 0.819 to 0.865, with declines most pronounced in Washington and
1394 Oregon. Apparent survival rates in Washington had been less than 80 percent in years leading up to
1395 2008, a rate that is unlikely to allow for sustainable populations (Forsman et al. 2011). Although less
1396 severe than in Washington and much of Oregon, all California study areas show declines in survival
1397 (Table 7).

1398 For most demographic study areas, changes in λ were driven mainly by changes in survival. This is
1399 consistent with the hypothetical expectation from a long-lived species with high variability in fecundity
1400 over time, and is also consistent with previous studies showing that annual rates of population change
1401 are most influenced by changes in adult survival (Noon and Biles 1990, Lande 1991, Blakesley et al.
1402 2001). This is a concerning finding because survival was shown to be declining on 10 of 11 study areas
1403 across the entire range of the subspecies, including all three California study areas. In the previous
1404 demographic analysis analyzing data from 1985-2003 (Anthony et al. 2006), declines in adult survival in
1405 Oregon had not been observed and only one study area in California showed declines, therefore
1406 declines in survival in the southern portion of the range occurred predominantly in the most recent five
1407 years for which data were available (2004-2008). The overall assessment from the most recent
1408 demographic study (Forsman et al. 2011) is that reproduction and recruitment have not been sufficient
1409 to balance losses due to mortality and emigration, so many of the populations on study areas have
1410 declined over the two decades included in the study.

1411 When the NWFP was implemented, it was assumed that Northern Spotted Owl populations would
1412 continue to decline for up to a few decades, but would gradually increase and eventually stabilize as

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1413 habitat protection and successional processes increased available habitat on reserve lands (USDA and
1414 USDI 1994). To date, five meta-analyses have been conducted on data from Northern Spotted Owl
1415 demographic study areas, with results readily available for three of the analyses. A sixth analysis is
1416 ongoing and will include all survey years through 2013. In the second meta-analysis which summarized
1417 results through 1993 (Burnham et al. 1996), no trend in fecundity was detected and survival was shown
1418 to be declining among adult female owls; λ was less than 1.0 for most study areas. The fourth meta-
1419 analysis which covered data through 2003 (Anthony et al. 2006) found evidence for declining fecundity
1420 at six study areas (although 95% confidence intervals overlapped zero for all six areas), and strong
1421 evidence that survival was declining on four of 14 study areas included in the analysis (two of which no
1422 longer participate in the demographic analysis). Mean λ across all study areas was also less than 1.0 with
1423 an annual rate of population decline estimated to be 3.7%, although only four study areas had 95%
1424 confidence intervals for estimates of λ that did not overlap 1.0 (Anthony et al. 2006). The fifth and most
1425 recent meta-analysis covers data through 2008 (Forsman et al. 2011) and provides strong evidence for a
1426 decline in fecundity on 5 of 11 study areas and strong evidence for declining survival on 10 of 11 study
1427 areas. After two decades of NWFP implementation, it is clear that the declining Northern Spotted Owl
1428 populations have not stabilized, and estimates of demographic rates indicate that across much of the
1429 range, the decline has accelerated. This is evident in the declining populations on seven of the 11 study
1430 areas, only two of which showed strong evidence for decline in the previous analysis.

1431 In California, two of three study areas (NWC and GDR) in the recent analysis were shown to be
1432 experiencing declines in fecundity and all California study areas showed declines in survival (Forsman et
1433 al. 2011). The previous analysis also found evidence of declining fecundity on two California study areas
1434 but found evidence for declining survival on only one (Anthony et al. 2006). Although estimates of λ for
1435 study areas in California are not as low as those in Washington and northern Oregon, negative trends in
1436 vital rates had led to population declines on at least two of three California study areas by 2008 (NWC
1437 and GDR). The decline at the NWC study areas had apparently not begun by 1994 (Franklin et al. 2000).
1438 Although Northern Spotted Owls at the southern portion of the range appear to have been temporally
1439 buffered from population declines, the ongoing and accelerating decline in demographic rates had
1440 effected populations in California by 2008.

1441 Most of the demographic study areas were established to evaluate the effectiveness of the NWFP and
1442 consist of federal lands or a mix of federal and nonfederal lands. Although not randomly chosen,
1443 Forsman et al. (2011) suggests that results from the demographic study areas are representative of
1444 federal lands and areas of mixed federal and private lands throughout the range of the Northern
1445 Spotted Owl because “the study areas were (1) large, covering about 9% of the range of the subspecies;
1446 (2) distributed across a broad geographic region and within most of the geographic provinces occupied
1447 by the owl; and (3) the percent cover of owl habitat was similar between our study areas and the
1448 surrounding landscapes”. The authors expressed less confidence that study areas reflected trends on
1449 non-federal lands because the two study areas consisting mainly of non-federal lands (GDR and HUP)
1450 are near the southern edge of the subspecies’ range and both are actively managed for Spotted Owl
1451 habitat. These two non-federal study areas might not accurately represent other non-federal lands in
1452 California because of the management mentioned above and because they are located in the California

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Coast and western edge of the California Klamath physiographic provinces, and may not accurately represent conditions in other parts of the California range, especially the California Cascades. The authors suggested that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands (Forsman et al. 2011).

Although results from the ongoing meta-analysis for the eleven demographic study areas are not yet available, recent reports from individual study areas in California (NWC, HUP, and GDR) provide information on current estimates for reproductive success and survival. At GDR, reproductive success (number of young fledged per monitored site) showed a negative trend from 1992-2014 (regression slope = -0.014), with a mean of 0.54 during this time period (GDRC 2015). This is a different metric of fecundity than used in the most recent demographic analysis (Forsman et al. 2011; number of female young produced per adult female), but shows a continuing decline in productivity since 2008. On HUP, mean reproductive rate (young fledged per monitored female; also a different measure of fecundity) from 1991-2013 was 0.42 with a range of 0.05 to 1.04 (Higley and Mendia 2013). During 2011, 2012 and 2013 HUP showed unusually low reproductive rates of 0.05, 0.13, and 0.06, respectively. In 2013, adult survival was approximately 0.8 on HUP (Higley and Mendia 2013), which is lower than that reported by Forsman et al. (2011). Annual apparent survival for territories surveyed on NWC averaged 0.848 for 1985-2014 (Franklin et al. 2015). Reproductive rate has also been reported for private timberlands outside of the demographic study areas, although monitoring and analysis approaches are not standardized as in the eleven demographic study areas, so direct comparisons are not possible. Humboldt Redwood Company reported a reproductive rate (number of young per pair) of 0.49 in 2014 (HRC 2015) and Mendocino Redwood Company reported a reproductive rate of approximately 0.12 in 2014 (MRC 2014). HRC (2013) noted a drop in reproductive rate since 2009. These more recent estimates of reproductive rate and survival since the last demographic meta-analysis (Forsman et al. 2011) are consistent with a continued decline within the demographic study areas in California.

As mentioned in the Life History section, most Spotted Owls do not breed every year and annual variation in reproductive effort and success is thought to be related to local weather conditions and fluctuations in prey abundance. This results in most areas having high variation in reproductive success between good years and bad years and can be seen in modeled rates of fecundity (Forsman et al. 2011). In the coastal portion of the Northern Spotted Owl range in California, many areas reported consistently low reproductive success from 2011-2013, including some of the lowest reproductive success rates on record in 2013. This is despite weather conditions in 2013 that would typically support good reproductive success. This was observed on many timber company lands (Calforests 2014, HRC 2014, GDRC 2015), tribal lands (Higley and Mendia 2013), and National Park land (Ellis et al. 2013). The reason for this widespread pattern of low reproductive success is not known.

In addition to providing rigorous estimates of survival, productivity, and population change across much of the range of the Northern Spotted Owl, the large amount of data and the regular demographic analyses allow for investigation of potential associations between population parameters and covariates that might explain estimates and trends (Forsman et al. 2011). Potential explanatory variables included in modeling during the most recent analysis of fecundity, survival, and λ included multiple weather and climate covariates, a habitat covariate, a Barred Owl covariate, and several other broad geographic

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covariates. Unlike studies that have modeled vital rates and potential explanatory variables at the scale of individual owl territories (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005), the meta-analysis evaluates covariates as an average effect across large study areas. The Barred Owl covariate was evaluated as the proportion of Northern Spotted Owl territories in each study area that had Barred Owls detected within a 1-km (0.62 mi) radius of activity centers. The habitat variable was the proportion of “suitable habitat” (based on Davis and Lint (2005), but generally characterized as containing large overstory conifers (dbh > 50cm) and canopy closure >70% in the study area). Although modeling average effect across large study areas is not as powerful at detecting effects that are influential at the territory scale (e.g., presence of Barred Owl or habitat conditions), data limitations required a coarser evaluation at the broad scale of the demographic analysis in order for methods to be consistently applied across study areas (Forsman et al. 2011). The broad demographic analysis found relatively weak associations between the amount of habitat and demographic rates, and somewhat larger effects of Barred Owl. These results, and those from more powerful territory-based studies, are discussed in the Habitat Requirements section and in the Threats section of this report.

Occupancy

Occupancy data are less resource-intensive to collect compared to data required to estimate the demographic parameters discussed above. Estimation of survival and reproduction requires the capturing and banding of owls at known sites, and multiple annual visits to all sites in order to recapture or re-sight owls, and to determine reproductive status. Occupancy data is based on the presence or absence of owls from known sites, and depending on the objectives of the monitoring does not necessarily require the monitoring of all sites each year. Due to this reduced requirement in survey effort and the necessity to visit known owl sites during pre-timber harvest monitoring, this type of data has frequently been collected and reported by timber companies and by other landowners (e.g. National Parks).

Although occupancy might appear to provide a substitute for estimates of survival, reproduction, or the rate of population change, it is not always appropriate to use an apparently stable occupancy rate to suggest a stable population size. As explained by Forsman et al. (1996),

“...it is possible that in a declining population, observed densities of territorial owls might not change during early years of the decline simply because territorial owls that died could be replaced by floaters (owls without territories) (Franklin 1992). Thus, significant changes in density of territorial owls might not become apparent for many years, especially if the rate of population decline was small (e.g., 1-2% per year).”

Therefore, a lack of a significant decline in observed owl numbers cannot necessarily confirm or refute estimates of survival or λ . Although little is known about the floater population of Northern Spotted Owls at any study area, other than that they exist and that they do not readily reply to broadcast calling, the number of floaters is finite. The perception of population stability due to establishment of territories by floaters cannot continue indefinitely in a constantly shrinking population. Depending on the rate of population decline (λ), the phenomenon should gradually disappear as the floater population is

Comment [A49]: Note to external reviewers:
The ongoing demographic analysis covering all survey years through 2013 will include occupancy modeling for the first time. Though we have included some preliminary results in this report when available (cited as “Dugger et al. in review”), we will update prior to finalizing if the full publication becomes available.

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depleted. If a study area has a relatively robust population of floaters, or if emigration into the study area occurs, the local population can decline for some time before being detected through declines in occupancy. Although declines in occupancy can indicate a reduction in local abundance when survey efforts are consistent over time (Bigley and Franklin 2004), a stable occupancy rate may not necessarily indicate that a population is stable.

Higley and Mendia (2013) observed inflated rates of occupancy on the Hoopa Valley Indian Reservation, and suggested that if owls are not color banded, it may be difficult to interpret stable occupancy rates. The authors believe that inflation of observed occupancy rates may be more likely in areas where Barred Owls are present and displace Spotted Owls:

“Furthermore, because our owls are color banded, we know that they are being observed in more than one territory per season... They are moving vast distances (several miles). Due to this movement, we may be seeing an inflated occupancy (use) rate on the landscape that is well above the actual rate. If this behavior exists in study areas without color-banded owls, there would be no way to determine whether owls in multiple sites were in fact the same individual.”

Although an evaluation of occupancy rates has not been included in previous demographic analyses, the authors of the most recently completed analysis note that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning, and few territorial owls could be found on some of the study areas in 2008 (Forsman et al. 2011). This is an important consideration in interpreting results of the demographic analysis because estimates of fecundity and survival rates are independent of population size. The estimated rates are per capita averages across for all owls in a study area and so do not incorporate any direct measure of population size. If a study area experiences a declining number of territorial owls, which on average are experiencing reductions in rates of fecundity, the result will be far fewer owls produced each year. Even if Northern Spotted Owls at a given study area experience stable rates of fecundity over time, areas with declining occupancy rates will produce fewer young overall. This phenomenon might also explain the relatively weak effect of Barred Owls on fecundity at some study areas (see discussion of Barred Owl in Threats section). If Northern Spotted Owls become displaced by Barred Owls, they are less likely to be detected (either because of increased mortality or because they are non-territorial and non-responsive to calls). Any Northern Spotted Owls not displaced may continue to breed at historic levels, resulting in no detectable reduction in fecundity on average, or they may breed at some unknown level in sub-prime habitat and remain undetected. However, the net effect is that fewer Northern Spotted Owls are produced (Forsman et al. 2011).

In order for estimates of occupancy to be valid, survey efforts must be consistent over time and the detection probability (the probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead to high variation in detection probability which can skew estimates of occupancy and other vital rates if not accounted for in the modeling process. Ideally the owl population would also be banded in order to address the concern of inflated occupancy rates observed by Higley and Mendia (2013), at least in areas where Barred Owl is present. The ongoing demographic analysis using data from the eleven demographic study areas and covering all survey years through 2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have

Comment [DK50]: These are very good points that I think we do try and make in the Discussion of Dugger et al. (2015)

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declined at all three California study areas, with 32-37% declines from 1995-2013 (Dugger et al. in review). All demographic study areas in Washington and Oregon have also experienced declines in occupancy, which is consistent with previous reports from these areas (Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011, Davis et al. 2013). Occupancy rates in Washington have declined by as much as 74% (Dugger et al. in review). Occupancy rates are a balance between rates of local territory extinction and rate of colonization. Barred Owls were shown to have a strong effect on occupancy by increasing the local territory extinction rate (Dugger et al. in review). There is also some evidence of that Northern Spotted Owl will not reoccupy empty sites if Barred Owls are present. Preliminary results also show a positive effect of habitat on colonization rates, and a negative effect of habitat in the core area on extinction rates (i.e. less habitat in the core area leads to higher extinction rate) (Dugger et al. in review).

Comment [DK51]: See other literature supporting this general effect on individual study areas: Dugger et al. 2011, Olson et al. 2005, Kroll et al. 2010, Yackulic et al. 2012, 2014

Outside of the three California demographic study areas, studies that have compiled robust datasets suitable for evaluation of Spotted Owl site occupancy in California are rare. In the southern Cascades and interior Klamath provinces of California, where there are no demographic study areas, Farber and Kroll (2012) compiled data from 1995-2009 using a consistent and rigorous annual survey effort at 63 Northern Spotted Owl sites located within a checkerboard landscape (intermixed federal and private ownership). Occupancy modeling showed that simple and pair Spotted Owl occupancy probabilities declined approximately 39% over the 15 year period; site occupancy for any owl declined from 0.81 (0.59–0.93) to 0.50 (0.39–0.60), and pair occupancy declined from 0.75 (0.56–0.87) to 0.46 (0.31–0.61). In addition to providing estimates of occupancy from the interior of the range in California that is relatively understudied, this study also provides a rigorous assessment of occupancy trends on private timberlands.

As an example of declining populations at California demographic study areas, the number of observed owls on NWC has declined from a high of 195 owls in 1992 to low counts of 62-67 owls since 2012 (Franklin et al. 2015). At HUP, the number of owls observed between 1992 and 2006 was between 60-70 owls each year; a steep decline since then has resulted in only 30 owls observed in 2013 (Higley and Mendia 2013). At the GDR density study area, the number of occupied sites declined from about 120-140 sites for years 1992-2004 to just over 80 occupied sites in 2008 (exact numbers not available; GDRC 2015). A partial recovery in number of occupied sites led to about 110 occupied sites by 2012; the authors attributed this increase to removal of Barred Owls and an increase in suitable habitat (GDRC 2015). Several study areas north of California have also undergone dramatic declines.

In the 97,000 acre Redwood National and State Parks, as many as 40 Northern Spotted Owl activity centers were identified during the 1990s. Occupancy rates are not available for the parks. However, by 2001 a large proportion of activity centers had become inactive, and subsequent intensive surveys revealed that most historical Spotted Owl territories now appear to be occupied by Barred Owls (Schmidt 2013). Data through 2012 indicated that at least 58 Barred Owl sites occurred within the parks, not including areas with single detections of Barred Owls. In 2012, Northern Spotted Owls were detected at just four territories in the parks, with only one pair observed; this was also the second consecutive year with no known reproduction of Northern Spotted Owl in the parks (Schmidt 2013).

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1608 In contrast to the above studies at demographic study areas and at other well-monitored areas that
1609 showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the
1610 study area, several industrial timber companies have concluded that Northern Spotted Owl occupancy
1611 rates have been stable on their lands, and that this indicates stable populations (Calforests 2014). In
1612 2014, the California Forestry Association hosted a Northern Spotted Owl Science Forum, to which
1613 members of the association were invited to present on monitoring efforts and status of Spotted Owls on
1614 their property. Twelve landowners, timber management companies, and non-profit groups presented
1615 on various aspects of timber operations as they relate to Northern Spotted Owls. Presentations included
1616 data on Northern Spotted Owl surveys, numbers, and population parameters, although the information
1617 presented varied by participant. Reports on estimated occupancy rates were included in many
1618 presentations and are summarized in Table 8 for nine companies.

1619 As discussed above, valid estimates of occupancy require consistent survey efforts over time, and
1620 modeling of occupancy rate must take into account detection probability. These requirements were
1621 rarely met in the occupancy estimates and trends reported by the timber companies (Calforests 2014).
1622 There is no standardized monitoring protocol used across the timber companies, and methods
1623 employed have been highly variable. In some cases, the level of detail at which methods are described
1624 does not allow for evaluation of occupancy estimates.

1625 Of nine companies reporting on some aspect of occupancy on their ownership, five reported a stable
1626 trend in occupancy with one company reporting that the population size is variable. Two companies
1627 reported a mix of stable, declining, or increasing occupancy, depending on the time period or the
1628 portion of the owl population assessed. In most cases the companies have reported on counts of
1629 occupied sites or on naïve estimates of occupancy (the proportion of surveyed sites that are occupied in
1630 a given year) without consideration of detection probability. Counts of occupied sites and detection
1631 probability are both dependent on survey effort. An example of this can be seen in data submitted by
1632 Mendocino Redwood Company, which shows a correlation between survey effort and estimates of
1633 occupancy.

1634 Green Diamond Resource Company, as a participant in the rangewide coordinated demographic studies
1635 since 1990, has the longest history of banding and monitoring work among the companies. Results from
1636 Green Diamond Resource Company are included in the demography section. Although results on
1637 occupancy modeling are preliminary, modeling revealed a more than 30% decline in occupancy from
1638 1995-2013 (Dugger et al. in review). A reduction in the rate of decline in recent years was attributed to
1639 the removal of Barred Owl from portions of the study area.

1640 Humboldt Redwood Company also has a fairly long history of monitoring, with consistent survey
1641 methods being used since 2002 and banding being conducted since 2003 as part of the HCP monitoring
1642 program (HRC 2014). Monitoring under the Humboldt Redwood Company HCP samples a subset of the
1643 land ownership in each year. Twenty percent of lands are surveyed each year, with the entire property
1644 surveyed every five years. However, core sites are monitored annually, including determination of
1645 occupancy, whereas other sites are sampled on a rotating basis. Core sites were established to
1646 represent activity centers that have had a history of occupancy and reproduction, and the HCP provides

Comment [DK52]: You'll have to show me the data to convince me that NSO occupancy rates on private lands are stable – only possible if they have no barred owls (like Mendocino Co.)

At the very least in Table 8, you need to note whether formal occupancy analyses were done (incorporating detection rates) or these were naïve estimates of apparent occupancy for each area.

Comment [DK53]: Right, so a single sentence or 2 dismissing this report is probably all that's needed. Don't waste time discussing results that in the end are unreliable (and which you then acknowledge are unreliable). Stick to the published literature wherever possible.

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1647 higher habitat retention requirements for these core sites. Therefore, sites which are monitored
1648 annually are those which meet minimum habitat requirements and have a higher history of use by
1649 Northern Spotted Owl, resulting in a biased sample. The sampling scheme therefore results in biased
1650 estimates of occupancy for the ownership as a whole. Also, because the non-core sites are sampled on a
1651 rotating basis, a different set of sites is sampled each year. It is unclear how this rotating sampling
1652 scheme may affect reported trends in occupancy. The sampling scheme included in the Humboldt
1653 Redwood Company HCP has the benefits of less intensive annual survey requirements and the ability to
1654 focus survey effort on sites with upcoming timber harvest or other management actions in order to
1655 meet the requirements of the HCP, but limits the ability to accurately determine occupancy rate for the
1656 ownership as a whole.

Comment [DK54]: See MacKenzie et al. (2006) – occupancy book. I think they discuss this approach. It can be OK for year-specific estimates of occupancy, but yes, problematic for comparing occupancy from year to year.....

1657 Campbell Global, L.L.C. manages timber lands for multiple owners, and reported on occupancy rates for
1658 two ownerships in Mendocino County (Calforests 2014). All known active activity centers were surveyed
1659 annually to determine occupancy status. Occupancy was first presented using simple count data for
1660 years 2000-2013, with no apparent trend in occupancy over time. The Spotted Owl population was
1661 reported to be dynamic but stable on these ownerships. Campbell Global also presented preliminary
1662 results of modeled occupancy dynamics (including estimation of detection probability) using data from
1663 the same ownerships from 1990-2010. Modeling showed that occupancy probabilities for single Spotted
1664 Owls began to decline in 2003. Pair occupancy declined by 16-30% during the initial portion of the time
1665 period before stabilizing in 1997. These results show how simple counts or naïve estimates of occupancy
1666 will not necessarily reflect true occupancy rates.

Comment [DK55]: Isn't this an analysis conducted by AJ Kroll? I thought he had an manuscript in progress – or was it on the Mendocino Co. lands below?

1667 The Mendocino Redwood Company is the only other company to model occupancy rates taking into
1668 account detection probability (Calforests 2014). As with the lands managed by Campbell Global, L.L.C.,
1669 when occupancy was presented using counts or naïve estimates there was no apparent trend (years
1670 included were 2001-2013). However, when occupancy modeling was conducted for a subset of years
1671 2001-2008, a slight decline in occupancy was found. Occupancy modeling was not conducted on data
1672 from more recent years.

1673 The variability in survey methods used, by companies, the tendency to reports of a counts or naïve
1674 estimates of occupancy without consideration of detection probability, the sometimes inconsistent
1675 methods used over time, and along with the sometimes limited description of methods, means there is
1676 little support for the timber Industry's conclusion that occupancy rates have been stable across
1677 ownerships over time. akes it difficult to interpret the reported occupancy rates and trends for most
1678 companies. This leads to some difficulty in comparing reported rates in timber company reports to other
1679 published estimates of occupancy and does not support a strong finding that occupancy rates have been
1680 stable across these ownerships over time.

Comment [DK56]: See above – this is the meat of this section – reduce discussion of results to the private lands that actually modeled occupancy (if you have that information) and exclude discussion of all the rest – we know naïve estimates of occupancy are biased if detection rates are <1.0 – and they are always <1.0.....particularly when BO are present.....

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Table 8. Occupancy estimates as presented in the Northern Spotted Owl Science Compendium in 2014 by participating timber companies with ownership in the range of the Northern Spotted Owl in California. See text for caution in interpreting these results.

Company	Pair Occupancy in 2013	Reported Occupancy Trend
Humboldt Redwood Company (Humboldt County)	0.85 (pairs only)	Stable
Sierra Pacific Industries (mainly Siskiyou and Shasta counties)	No rate provided, reported 48 known sites occupied	Stable
Conservation Fund (Mendocino and Sonoma counties)	No rate provided, reported 23 known sites occupied	Stable
Michigan-California Timber Company (Siskiyou County)	0.48	Stable
Green Diamond Resource Company (Humboldt and Del Norte counties)	0.83	1998-2008 Declining 2009-2011 Increase ¹
Crane Mills (mainly Tehama and Shasta counties)	No rate provided, reported 38 known sites occupied	No trend in occupancy noted
Mendocino Redwood Company (Mendocino and Sonoma counties)	0.69	Stable
Fruit Growers Supply Company (mainly Siskiyou County)	Approximately 0.95	Variable
Campbell Global (Mendocino, Siskiyou and Shasta counties)	>0.85 and >0.80 (singles) >0.85 and >0.70 (pairs) (estimates from 2010 occupancy analysis on two ownerships in Mendocino County)	Declining Stable

¹ The increase in occupancy starting in 2009 was attributed to the start of Barred Owl removals from the study area.

Comment [DK57]: If you retain this information – and maybe just putting it in a table and removing it from the text is the best way to retain it, add a column that denotes whether estimates of occupancy are “naïve”, or incorporate detection rates.

Source-Sink Dynamics

Source populations are those in which reproduction exceeds carrying capacity thereby providing a surplus of individuals, whereas sink populations are those where mortality exceeds local reproduction (Pulliam 1988, Dias 1996, Watkinson and Sutherland 1995). Pulliam (1988) was the landmark publication on source-sink population dynamics. Since then, The application of source-sink dynamics has been applied within many ecological studies to better understand movement (e.g., dispersal) interactions on the landscape while accounting for birth and death rates within population segments. Source populations are those in which reproduction exceeds carrying capacity thereby providing a surplus of individuals, whereas sink populations are those where mortality exceeds local reproduction (Pulliam 1988, Dias 1996, Watkinson and Sutherland 1995). Pseudo-sinks are populations that those populations

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that may be viable, but movement dynamics are difficult to distinguish based on complicated demographics and habitat connectivity (Watkinson and Sutherland 1995). These source-sink dynamics have been linked to habitat quality, generally with high quality habitat producing source populations, and low quality habitat producing sink populations (Dias 1996). Protected areas may serve different functions for vulnerable species depending on habitat quality and connectivity (Hansen 2011). Understanding source-sink populations can give us insight into appropriate and effective management actions that may benefit species habitat and populations at a local or range-wide level. For the Northern Spotted Owl, such principles are key to understanding connectivity (quality and function) between populations and how these populations may affect one another.

By applying source-sink modeling techniques and utilizing the immense amount of data available on Northern Spotted Owl life history and demography, Schumaker et al. (2014) characterized Northern Spotted Owl movement dynamics between modeling regions and physiographic provinces noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). For California, the Northern Spotted Owl populations within the Klamath region (Klamath West and Klamath East modeling regions; California Klamath physiographic province) and the Inner California Coast Range modeling region were identified as source populations, while the California Coast Range and California Cascade physiographic provinces were identified as sink populations (Table 9). Source-sink strength was substantial for the East Cascade South modeling region (sink), Klamath East region (source), Inner California Coast region (source), California Coast province (sink), and California Klamath province (source).

Table 9. Source and sink attributes within modeling region and physiographic province found in California (adapted from Table 2 in Schumaker et al. 2014). Includes percent of modeled range-wide population for each location, whether the location is a source or sink, and the strength of the sink/source as a percent of the best range-wide source or worst range-wide sink.

Location	Percent of population	Source or Sink	Source-Sink Strength
<i>Modeling Regions</i>			
East Cascade South	3.8	Sink	100
Redwood Coast	16.4	Sink	28.1
Klamath West	20.0	Source	51.1
Klamath East	17.1	Source	97.9
Inner California Coast	21.7	Source	100
<i>Physiographic Provinces</i>			
California Coast Range	16.6	Sink	100
California Cascades	2.8	Sink	35.9
California Klamath	36.4	Source	100

Schumaker et al. (2014) evaluated movement and contribution to overall population growth rate within modeling region and physiographic province source locations range-wide. Data for source locations in California is summarized in Table 10 and graphically in Figure 8. Klamath modeling regions (Klamath West and Klamath East) provided a flux of individuals within (e.g., Klamath West to Klamath East), and to the Cascade modeling regions (East Cascade South and West Cascades South), Redwood Coast, and Oregon Coast. Percent of net flux was most notable from Klamath East to East Cascade South regions. The Inner California Coast modeling region provided a flux of individuals to Klamath and East Cascade

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1728 South regions. The California Klamath province was identified as a source provided a flux of individuals
1729 to the California Coast Range, California Cascades and Oregon Klamath provinces, with net flux most
1730 notable to the California Coast Range province.

1731 **Table 10.** Net Flux and $\Delta\lambda^R$ for modeling region and physiographic province source locations in California (adapted
1732 from Table 3 in Schumaker et al. 2014). Net Flux represents movement from one location to another. $\Delta\lambda^R$
1733 represents the change in overall population growth rate.

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
<i>Modeling Regions</i>			
Klamath West	Redwood Coast	36.2	3.9
	Oregon Coast	49.5	45.9
	Klamath East	12.7	19.1
Klamath East	East Cascade South	100	85.1
	West Cascades South	36.0	27.4
Inner California Coast	Klamath West	44.4	28.3
	Klamath East	19.7	18.4
	East Cascades South	30.4	22.4
<i>Physiographic Provinces</i>			
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

1734

1735 [Schumaker et al. \(2014\)](#) results suggest that [Thus](#), California's population of Northern Spotted Owls is a
1736 significant component of, and source to the range-wide population ([Schumaker et al. 2014](#)). As a
1737 source, the Klamath region populations provide a source of owls to sink populations on the Coast and
1738 Cascade ranges. This concept is central to protection of owl habitat, especially dispersal habitat, for the
1739 continued persistence of Northern Spotted Owls across their range.

Comment [DK58]: At the moment.....seems to be changing as BO take a hold in CA (unfortunately).

1740 Existing Management

1741

1742 Land Ownership Patterns in Northern Spotted Owl Range

1743 The laws and regulations governing management of forests in the range of the Northern Spotted Owl
1744 vary depending on ownership. For this reason, the following discussion on existing management is
1745 partitioned based on ownership, with lands governed by a common set of regulations. In general,
1746 federal timberlands in the range of the Northern Spotted Owl are governed by the NWFP, with some
1747 federal ownership subject to more restrictive management (e.g., National Parks). Although tribal lands
1748 are subject to federal regulations for timber management, the tribes in the range of the Northern
1749 Spotted Owl in California have developed Forest Management Plans (FMPs) and are discussed
1750 separately. Nonfederal lands in California must comply with the Forest Practice Rules for commercial
1751 timber harvest. There are several options for complying with the Forest Practice Rules when developing
1752 a THP depending on several factors including, but not limited to, size of ownership, presence of Spotted

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Owl activity centers, and qualification for an exemption. We present these options below and discuss the most important options in greater detail.

Federal lands contain less than half of the total forest land in the range of the Northern Spotted Owl (Mouer et al. 2011). Of an estimated 14.3 million acres of forested lands within the Northern Spotted Owl range in California, 6.4 million acres are publicly owned and 7.8 million acres are privately owned (2.3 million acres industrial and 5.5 million acres non-industrial) (Calforests 2013). Federal lands in the Northern Spotted Owl range in California are more concentrated in the interior portion of the range, with most USFS and BLM land occurring in the Klamath and Cascades provinces (Figure 9). The majority of the California Coast Province is under private ownership, though large tracts of public land occur along the coast, including both State and National parks. The most interior portion of the Northern Spotted Owl range in California (Cascades and eastern portion of Klamath provinces) has a combination of federal and private land, sometimes in a checkerboard pattern as a result of historical railway land grants (Figure 9). Tribal lands in California collectively represent 167,401 acres in the range of the Northern Spotted Owl and are mostly within the Coast Province and the western portion of the Klamath Province.

Critical Habitat Designation

In 2012, the USFWS revised the critical habitat designation for the Northern Spotted Owl (USFWS 2012). The purpose of critical habitat is to designate land distributed within the entire range of the Northern Spotted Owl that provides “features essential for the conservation of a species and that may require special management”, which includes forest types supporting the needs of territorial owl pairs throughout the year, including nesting, roosting, foraging, and dispersal habitat (USFWS website - <http://www.fws.gov/oregonfwo/species/data/northernspottedowl/CriticalHabitat/default.asp>). Critical habitat was identified using a modeling framework that considered both habitat requirements and demographic data, and considered uncertainties such as impacts of Barred Owl, climate change, and wildfire risk. Range wide, 9.29 million acres of critical habitat is on federal land and 291,570 acres is on state land. All private lands and the majority of state lands were excluded from the designation. A map of critical habitat for California is shown in Figure 10, which includes 2,014,388 acres on federal land, and 49,542 acres on state land. For management purposes, critical habitat only affects federal actions and do not provide additional protection on non-federal lands, unless proposed activities involve federal funding or permitting.

Federal Lands

Northwest Forest Plan

In the early 1990s, concern was raised regarding the adequacy of federal plans to protect the Northern Spotted Owl. Litigation resulted in a court injunction on harvest of owl habitat (mature and old-growth forest). In 1993, President Clinton directed the Forest Ecosystem Management Assessment Team (FEMAT) to develop long-term management alternatives for maintaining and restoring habitat

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1789 conditions to maintain well-distributed and viable populations of late-successional- and old-growth-
1790 related species. The FEMAT was instructed to maintain and restore habitat conditions for the Northern
1791 Spotted Owl (as well as the Marbled Murrelet). The FEMAT was also instructed to maintain and restore
1792 habitat conditions to support viable populations, well-distributed across current ranges, of all species
1793 known or reasonably expected to be associated with old-growth habitat conditions; and to maintain or
1794 create a connected, interactive, old-growth forest ecosystem on federal lands (FEMAT 1993; Thomas et
1795 al. 2006). In developing alternatives, the members of FEMAT relied heavily on recently completed
1796 conservation assessments, including a regional conservation strategy for the Northern Spotted Owl
1797 (Thomas et al. 1990). The analysis of the FEMAT alternatives in a final supplemental environmental
1798 impact statement (USDA and BLM 1994a) led to adoption of the land-allocation strategy contained in
1799 the record of decision (USDA and BLM 1994b), hereinafter referred to as the Northwest Forest Plan. The
1800 NWFP amended nineteen existing USFS and seven BLM resource management plans within the range of
1801 Northern Spotted Owl. The intention of the NWFP is to improve current conditions and alter past
1802 practices that were detrimental to late-successional species by protecting large blocks of remaining late-
1803 successional and old-growth forests, and to provide for the regrowth and replacement of previously
1804 harvested late-successional forest stands. To help facilitate decision-making and issue resolution during
1805 the implementation of the NWFP, the Regional Ecosystem Office was formed and is made up of
1806 members from USFS, BLM, National Park Service (NPS), and Environmental Protection Agency (EPA).

Comment [DK59]: Probably wise to include something about “meeting needs for forest products” or something like that

1807 The NWFP covers approximately 24 million acres of federal land within the range of the Northern
1808 Spotted Owl, about 67% of which are allocated in one of several “reserved” land use designations (see
1809 discussion of designations and Table 11). In California, approximately 3.5 million acres of federal lands
1810 fall under the NWFP as reserved land. This is approximately 6 percent of the 57 million acres of forested
1811 habitat within the Northern Spotted Owl’s California range. Reserved lands are intended to support
1812 groups of reproducing owl pairs across the species’ range. Unreserved land is defined as the federal land
1813 between reserved lands and is intended to provide recruitment of new owls into the territorial
1814 populations and is important for dispersal and movement of owls between larger reserves.

Comment [DK60]: Where does this come from? Davis et al. 2015?? You should probably incorporate most recent estimates of NSO habitat in CA from Davis et al. (2015) – new GTR in press I believe.

1815 **Table 11.** Land-use allocations in the Northwest Forest Plan (adapted from Thomas et al. 2006)

Land-use allocation	Approximate Acres (%)
Congressionally reserved areas	7,323,783 (30)
Late-successional reserves	7,433,970 (30)
Managed late-successional reserves	102,242 (1)
Adaptive management areas	1,522,448 (6)
Administratively withdrawn areas	1,477,730 (6)
Riparian reserves	2,628,621 (11)
Matrix	3,976,996 (16)
<i>Total</i>	<i>24,465,790 (100)</i>

1816

1817 Reserved land includes late-successional reserves (LSRs), managed late-successional areas (managed
1818 LSAs), congressionally reserved lands, and larger blocks of administratively withdrawn lands. The LSRs
1819 cover about 30% of the NWFP area and were located to protect areas with concentrations of high-

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1820 quality late-successional and old-growth forest on federal lands and to meet the habitat requirements of
1821 the Northern Spotted Owl (Thomas et al. 2006). Most LSRs were designed to accommodate at least 20
1822 pairs of Northern Spotted Owls (FEMAT 1993). Timber harvesting is generally prohibited in LSRs.
1823 However, silviculture treatments (including thinning in stands less than 80 years old west of the
1824 Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit
1825 the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging
1826 is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events
1827 such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that
1828 were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National
1829 Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district
1830 plans as being withdrawn from timber production and include recreational and visual areas, back
1831 country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily
1832 in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with
1833 smaller amounts of reserved lands on the coast (Figure 11).

1834 Unreserved land includes the matrix, adaptive management areas (AMAs), riparian reserves, small tracts
1835 of administratively withdrawn lands, and other small reserved areas such as 100-acre owl core areas.
1836 The matrix represents the federal land not included in any of the other allocations and is the area where
1837 most timber harvesting and other silviculture activities occur. However, the matrix does contain non-
1838 forested areas as well as forested areas that may be unsuited for timber production. Three of the major
1839 standards and guidelines for matrix land management are: (1) a renewable supply of large down logs
1840 must be in place; (2) at least 15% of the green trees on each regeneration harvest unit located on
1841 National Forest land must be retained; and (3) 100 acres of late-successional habitat around owl ACs
1842 must be protected (USDA and BLM 1994b). Timber harvesting is allowed within AMAs and like the
1843 matrix lands, AMAs are subject to the standards in the NWFP and in individual forest and district plans.
1844 Riparian reserves are a system of reserves defined by a set distance on each side of perennial and
1845 intermittent streams (Thomas et al. 2006) and may provide dispersal habitat for Northern Spotted Owls.

1846 Standards and guidelines for the management of both reserved and unreserved lands are described in
1847 the Record of Decision associated with the NWFP (USDA and BLM 1994b, Attachment A). A summary of
1848 management on each land use designation is provided below.

1849 Late Successional Reserves:

1850 Before habitat manipulation activities occur on LSRs, management assessments must be prepared.
1851 These assessments include a history and inventory of overall vegetative conditions, a list of identified
1852 late-successional associated species existing within the LSR, a history and description of current land
1853 uses within the reserve, a fire management plan, criteria for developing appropriate treatments,
1854 identification of specific areas that could be treated under those criteria, a proposed implementation
1855 schedule tiered to higher order plans, and proposed monitoring and evaluation components to help
1856 evaluate if future activities are carried out as intended and achieve desired results. The following
1857 standards must be followed for timber management activities in LSRs:

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- West of the Cascades – No timber harvest is allowed in stands over 80 years old. Thinning (pre-commercial and commercial) may occur in stands up to 80 years old in order to encourage development of old-growth characteristics.
- East of the Cascades and in California Klamath Province – Silviculture activities should be designed to reduce catastrophic insect, disease, and fire threats. Treatments should be designed to provide fuel breaks but should not generally result in degeneration of currently suitable owl habitat or other late-successional conditions. Risk reduction activities should focus on young stands but activities in older stands may be undertaken if levels of fire risk are particularly high.
- Salvage in disturbed sites of less than 10 acres is not appropriate. Salvage should occur only in stands where disturbance has reduced canopy closure to less than 40%. All standing living trees should be retained, including those injured (e.g., scorched) but likely to survive. Snags that are likely to persist until late-successional conditions have developed should be retained. Appropriate levels of coarse woody debris should be retained. Some salvage will be allowed when it is essential to reduce fire risk or insect damage to late-successional forest conditions.

Managed Late Successional Areas:

Innovative silviculture techniques may be applied in managed LSRs. Proposed management activities are subject to review by the Regional Ecosystem Office, although some activities may be exempt from review. Within managed LSRs, certain silviculture treatments and fire hazard reduction treatments are allowed to help prevent complete stand destruction from large catastrophic events such as high intensity, high severity fires; or disease or insect epidemics. Managed LSAs should have management assessments as described for LSRs. Standards and guidelines for multiple-use activities other than silviculture are the same as for LSRs.

Congressionally Reserved Lands:

These lands are managed according to existing laws and guidelines established when the lands were set aside, and are generally managed to preserve natural resources (e.g., The National Park Service Organic Act of 1916, the National Parks Omnibus Management Act of 1998).

Administratively Withdrawn Areas:

There are no specific timber/silviculture standards and guidelines associated with administratively withdrawn areas. These areas have been identified as withdrawn from timber production in forest or district plans.

Riparian Reserves:

Riparian Reserves are managed to meet objectives of the Aquatic Conservation Strategy to help protect fish habitat and restore water quality. Timber harvest is prohibited within riparian reserves, including fuelwood cutting and salvaging (although some exceptions are made). Fuel treatment and fire suppression strategies and practices implemented within these areas are designed to minimize disturbance.

Matrix Lands:

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Matrix lands are open to timber harvest subject to the standards in the NWFP and in the individual forest and district plans. The objective for Matrix lands is to “provide coarse woody debris well distributed across the landscape in a manner which meets the needs of species and provides for ecological functions” (USDA and BLM 1994b). Standards for Matrix lands in the NWFP include:

- Coarse woody debris that is already on the ground is retained and protected from disturbance to the greatest extent possible during logging and other land management activities that might destroy the integrity of the substrate.
- Retention of at least 15% of the area associated with each cutting unit (stand).
- In general, 70% of the total area to be retained should be aggregates of moderate to larger size (0.5 to 2.5 acres or more) with the remainder as dispersed structures (individual trees, and possibly including smaller clumps less than 0.5 acres). Patches and dispersed retention should include the largest, oldest live trees, decadent or leaning trees, and hard snags occurring in the unit. Patches should be retained indefinitely (i.e., through multiple rotations to provide support for organisms that require very old forests).
- 100 acres of the best Northern Spotted Owl habitat must be retained as close to the nest site or owl activity center as possible for all known activity centers located on federal lands in the matrix and AMAs. These areas are managed in compliance with LSR management guidelines and are to be maintained even if Northern Spotted Owls no longer occupy them.

Adaptive Management Areas:

AMAs were intended to be focal areas for implementing innovative methods of ecological conservation and restoration, while meeting economic and social goals. Although there have been some successes in experimentation, most AMAs have been managed similarly to Matrix lands (Thomas et al. 2006). The NWFP established 10 AMAs, two of which are in California: Goosenest in northeastern California and Hayfork, which is located mostly in the Klamath province. One of the primary goals of the Goosenest AMA is to investigate means of accelerating the development of late-successional forest properties in pine forests. Mechanical treatments (forest thinning) and prescribed fire have been used experimentally to evaluate effect on development of late-successional forest properties in pine forests (Ritchie 2005). The emphasis for Hayfork is to investigate effects of forest management practices on the landscape, including partial cutting, prescribed burning, and low-impact approaches to forest harvest.

Standards and guidelines for LSRs and Congressionally Reserved Areas are followed where they fall within AMAs.

Section 7 Consultations

Section 7 of the Endangered Species Act requires all federal agencies to consult with the USFWS to ensure that any timber management action authorized, funded, or carried out by federal agencies is not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat (16 U.S.C. § 1536 subd. (a); 50 C.F.R. § 402). Section 7 requires the permitting instrument (i.e.,

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1934 biological opinion or letter of concurrence) to include measures to minimize the level of take to
1935 Northern Spotted Owl. Examples of take minimization measures may include:

- 1936 • Restricted use of heavy equipment during the breeding season
- 1937 • Retention of larger trees owl nesting/roosting and foraging habitat
- 1938 • Retention of large snags and down logs within thinning units
- 1939 • Retention of hardwoods
- 1940 • Limited thinning within Riparian Reserves
- 1941 • Monitoring and surveys for Northern Spotted Owl throughout projects
- 1942

1943 *Forest Stewardship Contracting*

1944 The Agricultural Act of 2014 (“Agricultural Act of 2014, Section 8205, Stewardship End Result
1945 Contracting Projects”) grants the USFS and BLM authority to enter into stewardship contracting with
1946 private persons or public entities to perform services to “achieve land management goals for the
1947 national forests or public lands that meet local and rural community needs” (USFS 2009). Agreements
1948 allow contractors to remove forest products (goods) in exchange for performing restoration projects
1949 (services), the cost of which is offset by the value of the goods. Agreements may extend for up to 10
1950 years.

1951 Since the new authority became law, the USFS has awarded more than 30 stewardship projects. It is
1952 unknown how many USFS stewardship projects are in California. There are some inconsistencies in
1953 information regarding the number of BLM stewardship projects. The BLM Stewardship Contracting Fact
1954 Sheet
1955 ([http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.da](http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf)
1956 [t/stcontrBLM_Fact0115.pdf](http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf)) lists two stewardship projects that do not occur in California. However, the
1957 BLM website (http://www.blm.gov/wo/st/en/prog/more/forests_and_woodland/0.html) lists three
1958 forest stewardships in California: Weaverville Community Forest, South Knob, and Hobo Camp.

1959 *Bureau of Land Management*

1960 The standards and guidelines from the NWFP apply except where existing resource management plans
1961 are more restrictive or provide greater benefits to late-successional forest related species.

1962 Headwaters Forest Reserve

1963 Headwaters Forest Reserve is located in the north coast region of California and was purchased by the
1964 Secretary of Interior and the State of California in 1999 to preserve a large stand of old-growth redwood
1965 forest. The Headwaters Forest Reserve Resource Management Plan (USDOI et al. 2003; USDOI and BLM
1966 2004a) was developed with the goal to restore and maintain ecological integrity and to study ecological
1967 processes within the Reserve to improve management. Recreation and other management activities are
1968 constrained as necessary to be consistent with that primary goal. Old-growth forest habitat within the

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1969 Reserve is managed to leave those systems undisturbed as core areas of optimal habitat. Second-growth
1970 forests are managed using tree thinning for restoration of old-growth characteristics. Priority is given to
1971 revegetating watershed restoration sites in old-growth areas and to treating harvested stands with old-
1972 growth remnants. Harvested stands that comprise early-mature and older seral stages (i.e., stands with
1973 an average stem diameter over 12 inches) are generally not thinned. Density-management treatments
1974 do not yield commercial forest products; all biomass is left on-site and may be lopped and scattered,
1975 piled and burned, or chipped. Chain saws, mechanical brush cutters, and chippers may be used.
1976 Permanent or temporary roads or skid trails are not developed for access for treatment sites, but
1977 temporary access routes may be developed where they will be subsequently removed during watershed
1978 restoration activities.

1979 The desired outcome for Northern Spotted Owl is protection of existing habitat and expansion of
1980 suitable habitat for nesting, roosting, foraging, and dispersal habitat at the Reserve. The Resource
1981 Management Plan allows for the restoration of up to 2,757 acres of previously harvested stands. No
1982 suitable habitat for Northern Spotted Owl is to be removed or degraded during watershed restoration,
1983 forest restoration, or trail development. To the extent practicable, activities will be buffered from
1984 Northern Spotted Owl nesting habitat during the period of February 1 through July 31 by the use of
1985 vegetative screening or topographic screening and establishment of seasonal operating periods or a
1986 distance buffer of up to 0.25 mile. Off trail hiking is prohibited year-round.

1987 Fuels in second-growth forests are managed through tree thinning with materials lopped and scattered,
1988 piled and burned, or chipped; broadcast burning is not employed within the Reserve. Fuels are not
1989 managed in old-growth forests and generally not in second-growth forest once they achieve early-
1990 mature seral stage. Fire suppression uses a minimum-impact strategy. In second-growth forests dozers
1991 may be used; resource damage will be minimized and full rehabilitation of dozer fire lines will be
1992 required after fire suppression. In old-growth forests road access will be limited to existing road
1993 systems; hand crews or helicopter bucket drops may be deployed to attempt to contain fire.

1994 King Range National Conservation Area

1995 The King Range National Conservation Area (NCA) is located along the northern California coast about
1996 sixty miles south of Eureka and 200 miles north of San Francisco. The King Range NCA Management Plan
1997 (USDOI and BLM 2004b; USDOI and BLM 2005) applies to 68,000 acres of forested land. All of the
1998 forested lands in the planning area have been designated as a LSR under the NWFP, and therefore must
1999 be managed to promote late-successional forest characteristics. All active forest management activities
2000 in the Management Plan are focused only in the Front Country Zone, 25,661 acre zone representing a
2001 broad mix of uses and tools for management. Forest management activities in this zone are intended to
2002 develop more natural stand characteristics in areas that were previously harvested, improve watershed
2003 and fisheries health, and protection from wildfire risk. Some of these previously-logged areas have
2004 burned in high intensity fires, or are at risk for future fires of stand-replacing intensity. The primary goal
2005 in silvicultural treatments is to increase the Douglas-fir component in tanoak dominated stands, and
2006 “fireproof” this Douglas-fir component so that it has a greater chance to reach maturity.

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2007 The Management Plan calls for the protection of sufficient Northern Spotted Owl habitat to attract and
2008 support 20 breeding pairs within the King Range NCA, as well as monitoring of known owl sites and
2009 periodic surveys in suitable habitat. At the time of the Management Plan development (2004), there
2010 were 12-14 known Spotted Owl activity centers in the King Range NCA. No timber harvests takes place in
2011 those activity centers.

2012 *National Park Service*

2013 Redwood National and State Parks

2014 Redwood National Park was established in 1968 and was expanded in 1978. Three California state parks
2015 established in the 1920s—Prairie Creek Redwoods State Park, Del Norte Coast Redwoods State Park, and
2016 Jedediah Smith Redwoods—were included within the 1968 congressionally designated national park
2017 boundary. Since 1994, the four park units have been managed jointly as Redwood National and State
2018 Parks (RNSP) to the greatest extent possible, although the state parks are administered by the California
2019 Department of Parks and Recreation and the national park is administered by the NPS. Collectively,
2020 RNSP covers approximately 131,983 acres of land in northwest California reaching from the shoreline of
2021 the Pacific Ocean to the mountains of the Coast Range.

2022 In 2000, a joint federal-state management plan was developed to provide a clearly defined, coordinated
2023 direction for resource preservation and visitor use and a basic foundation for managing these four parks
2024 (NPS 2000a, NPS 2000b). There are nine management zones within the RNSP, each with different types
2025 and levels of use, management, and facilities that are allowed. Three zones cover most of the combined
2026 park area – the two backcountry zones (42.1% mechanized and 13.3% nonmechanized), and the
2027 primitive zone (32.6%). The backcountry zones and primitive zone have the most restricted access, and
2028 resource modification and degradation from visitor use in these zones is low. The remaining 12% of the
2029 park area is made up of six relatively small zones which are managed for various resources and for
2030 visitor operational needs.

2031 The RNSP General Management Plan (NPS 2000b) includes programs for watershed restoration,
2032 vegetation management, cultural resource management, interpretation and education, and facility
2033 development. Under the watershed restoration program, abandoned logging roads that contribute
2034 unnatural amounts of sediments into streams or threaten redwoods along park streams will be removed
2035 or treated to reduce erosion. The vegetation management program includes use of silvicultural
2036 techniques in second-growth forests to accelerate the return of characteristics found in old-growth
2037 forests and management of fire to support resource management strategies, including restoration of
2038 fire in old-growth forests.

2039 Prior to timber removal, the NPS will evaluate trees that are potential suitable nesting habitat for
2040 Northern Spotted Owl. The NPS take measures to reduce noise disturbance and loss of suitable habitat
2041 within one mile of occupied and unsurveyed potential suitable nesting habitat by operating outside the
2042 breeding season, using quiet equipment, or by implementing daily limited operating periods for heavy

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2043 equipment during the breeding season. Protective buffer zones are used around known owl nest sites
2044 where visitor use activities are likely to result in disturbance.

2045 In 1978, Congress expanded RNSP to include 38,000 acres that had been logged between 1950 and 1978
2046 using clearcut tractor logging. With the expansion of the RNSP, commercial operations including active
2047 forest management and silviculture thinning ceased which resulted in second-growth forest conditions
2048 “considered unhealthy from both a silviculture and an ecological standpoint” (NPS 2008, NPS 2009a).
2049 Many of the second-growth forest stands were primarily high-density, even-aged Douglas-fir stands with
2050 little canopy structure and no understory development. The focus of second-growth forest restoration is
2051 to reduce stand density (thinning) to promote growth of remaining trees while protecting adjacent old-
2052 growth forests, as well as maintaining water quality in riparian habitats, minimizing tanoak tree
2053 disturbance, and minimizing excessive fuel build-up on the forest floor.

2054 In 2009, the NPS planned to apply thinning prescriptions throughout 1,710 acres in the South Fork of
2055 Lost Man Creek, with the prescription dependent upon slope steepness, available road access, presence
2056 of streams and wetlands, tanoak density, and proximity to old growth forest.

2057 The USFWS issued a Biological Opinion (file number 8-14-2004-2133 81331-2008-F-00027, dated
2058 December 19, 2007) that concurred with the NPS determination that the project may affect but is not
2059 likely to adversely affect the Northern Spotted Owl. The project was expected to alter approximately
2060 1,539 acres of suitable Northern Spotted Owl habitat. However, the habitat was considered poor quality
2061 and the short-term adverse effects on owls from habitat alteration to be negligible. The project was
2062 expected to have long-term benefits for Northern Spotted Owl due to retention and protection of
2063 deformed trees and snags, and habitat improvement through acceleration of development of late-
2064 successional forest structure.

2065 In 2011, Redwood National Park completed a project to thin about 1,700 acres of second growth forest
2066 in the South Fork of Lost Man Creek (near the community of Orick) to accelerate the restoration of old-
2067 growth characteristics and functions.

2068 The RNSP General Management Plan called for preparation of a comprehensive trail and backcountry
2069 management plan to guide the development of an expanded trail system and prescribe policies and
2070 regulations for the use of backcountry areas by hikers, bicyclists, and equestrians. The Trail and
2071 Backcountry Management Plan (NPS 2009b) details the construction of seven hiking trails totaling 14.6
2072 miles, establishment of two bike trails totaling 10.3 miles, and construction of two new backcountry
2073 camps. Avoidance and minimization measures during construction include above ambient noise
2074 producing work conducted outside of the marbled murrelet noise restriction period (March 24-
2075 September 15) and Northern Spotted Owl presence surveys prior to construction (NPS and CDPR 2013).

2076 Fire management in RNSP includes suppression of wildfires, prescribed fire, mechanical fuel reduction,
2077 fire ecology research and fire effects monitoring, and fire operations planning (NPS 2010a, NPS 2010b).
2078 Fire suppression preparations include installing water tanks, preparing access roads, and removing
2079 hazardous fuels. Management actions are designed to avoid or minimize adverse effects on listed,
2080 proposed, or candidate threatened or endangered species and minimizes the effects on sensitive

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2081 species. The NPS has developed guidelines to reduce or eliminate potential adverse effects on sensitive
2082 species from fire suppression in RNSP.

2083 Point Reyes National Seashore and Muir Woods National Monument

2084 The Point Reyes National Seashore (PRNS) was established in 1962 and is located along the coast just
2085 north of San Francisco. The General Management Plan and Environmental Impact Statement for PRNS
2086 are currently under development.

2087 Due to a better understanding of the role of fire in ecosystem preservation and reducing fire risk, in
2088 2004 the NPS proposed to revise PRNS's Fire Management Plan to expand the use of prescribed fire and
2089 mechanical treatment for all lands under its management (NPS 2004). In 2006, the Operational Strategy
2090 for the Fire Management Plan was published (NPS 2006a). The planning area for the Fire Management
2091 Plan includes the 70,046-acre PRNS as well as 18,000 acres of the Northern District of Golden Gate
2092 National Recreation Area. The Fire Management Plan allows up to 3,500 acres per year to be treated
2093 using prescribed fire and mechanical treatments. Measures in Northern Spotted Owl habitat include:

- 2094 • Annually identify and map areas where Spotted Owls are nesting.
- 2095 • Protect occupied and previously used nest sites from unplanned ignitions.
- 2096 • Do not conduct prescribed burns within 400 meters of an occupied or previously used nest
2097 site.
- 2098 • Do not conduct mechanical treatments with mechanized equipment within 400 meters of an
2099 occupied or previously used nest site between February 1 and July 31 (breeding season).
- 2100 • Conduct post-treatment monitoring to ascertain any impacts.

2101

2102 Muir Woods National Monument is managed by the NPS as part of the Golden Gate National Recreation
2103 Area. The General Management Plan Environmental Impact Statement for the Golden Gate National
2104 Recreation Area and Muir Woods was completed in 2014 (NPS 2014). The Record of Decision was
2105 expected to be completed in spring 2014 but has not been completed to date.

2106 The Fire Management Plan for Muir Woods allows up to 595 acres to be treated per year using
2107 mechanical treatments and prescribed fire (NPS 2006b). Measures to protect Northern Spotted Owl
2108 include:

- 2109 • Treatment activities or any noise generation above ambient noise levels will not occur within
2110 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential
2111 Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as
2112 surveys conforming to accepted protocol have determined that the site is unoccupied or non-
2113 nesting or nest failure is confirmed.
- 2114 • Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially
2115 alter the percent cover of canopy overstory and will preserve multilayered structure. When
2116 shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy

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- 2117 will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency
2118 vehicle clearance.
- 2119 • Prior to fire management activities, project areas will be surveyed for the presence of dusky
2120 footed woodrat nests. If feasible, woodrat nests will be protected.
 - 2121 • Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a
2122 determination is made that the native tree presents a clear hazard in the event of a fire or
2123 cutting is the only option to reduce high fuel loading.
 - 2124 • The fire management officer will arrange for qualified biologists to conduct post-project
2125 monitoring to determine short- and long-term effects of fire management actions on activity
2126 centers if resources are available.

2127 Tribal Lands

2128 *Hoopa Valley Indian Reservation*

2130 The Hoopa Valley Indian Reservation is the largest reservation in California encompassing 90,767 acres,
2131 and located in the northeastern corner of Humboldt County. The Hoopa Valley Tribe has recently
2132 adopted a revised Forest Management Plan (FMP) covering the period of 2011-2026 (Higley 2012). The
2133 annual allowable timber harvest has been determined to be 8.889 million board feet (MBF) net per year
2134 of conifer volume and 3.1 MBF net of hardwood volume to be harvested within the Reservation.
2135 Northern Spotted Owl habitat losses are expected from implementation of the FMP due to timber
2136 harvest, urban development, road construction, and prairie restoration. About 8,980 acres of roosting-
2137 foraging and nesting-roosting-foraging habitat are estimated to be lost to timber harvest over the period
2138 covered by the FMP. These acres will be temporarily rendered unsuitable to Northern Spotted Owl,
2139 although the FMP notes that habitat will “recover eventually to at least foraging dispersal but likely to
2140 roosting-foraging habitat...within 30-40 years because of the retention of large structures within all
2141 units” (Higley 2012). Implementation of the FMP and associated projects will result in a decline in total
2142 suitable habitat by approximately 4.4% by the end of the planning period in 2026. Dispersal habitat will
2143 be reduced by approximately 4.9% at the end of 2021 but is expected to rebound to a net reduction of
2144 0.9% by 2026.

2145 The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late
2146 successional reserves to the north, south, and east, and Redwood National Park to the northwest. The
2147 reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40
2148 pairs of owls at all times during the planning period. However, the plan notes this number of Northern
2149 Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009
2150 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl
2151 detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning
2152 in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

2153 Eight forested management units noted in the FMP will retain Northern Spotted Owl dispersal habitat.
2154 None of the forested management units will dip below 50% cover of dispersal or higher quality habitat.

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2155 The lowest level of owl habitat retention will occur within the Hopkins management unit, which at 72%
2156 at the time of the publication of the FMP, was projected to drop to 64% in 2012 and increase to 81% by
2157 2026.

2158 The FMP includes management actions to mitigate affects to Northern Spotted Owl including land
2159 allocation restrictions, requirements for structural retention within timber sale units and hardwood
2160 management guidelines, and are inclusive of:

- 2161 • The no cut land allocation includes 24,581 acres of which 21,104 acres were forested as of 2011
2162 with stem exclusion or larger size class strata including 10,134 acres of old growth.
- 2163 • 2,819 acres are allocated as reserved for threatened and endangered species. 73 acres are
2164 specifically reserved to protect Northern Spotted Owl nesting core areas.
- 2165 • Seasonal restrictions will apply to all disturbance activities resulting from logging, site
2166 preparation, stand improvement, burning, road construction or reconstruction, and watershed
2167 restoration projects, etc. within 0.25 miles of any known Northern Spotted Owl pair at least until
2168 nesting status is determined from February 1 until July 31. Activities, which modify suitable
2169 nesting/roosting habitat, such as logging, will be further restricted until September 15 of each
2170 year or until the young owls are determined to be capable of moving away from the area or the
2171 reproductive attempt has been determined to have failed. For territories that have been
2172 surveyed continually and found to be unoccupied for 2 or more years, no restrictions shall be
2173 imposed.

2174 *Yurok Indian Reservation*

2175 The Yurok Indian Reservation is located in Del Norte and Humboldt counties inclusive of one-mile on
2176 each side of the Klamath River along a 44-mile stretch. There are approximately 59,000 acres in the
2177 entire Yurok Indian Reservation, and of these, approximately 3,320 acres are forested Tribal trust lands
2178 (i.e., land that the federal government holds legal title to but the beneficial interest remains with the
2179 Tribe), and 2,171 acres are forested allotted lands held in trust (Erler 2012). The remaining lands are fee
2180 lands (i.e., land acquired by the Tribe under legal title outside the boundaries of the Reservation, and in
2181 this case is primarily owned by Green Diamond Resource Company), which are managed intensively for
2182 timber products. Total forested Tribal ownership is 36,637 acres.

2183 The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all
2184 Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for intensive
2185 surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then
2186 dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites.
2187 The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest
2188 reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity
2189 centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl
2190 habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on
2191 disturbance activities within 0.25 mile of Northern Spotted Owl nest.

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2192 *Round Valley Indian Reservation*

2193 The Round Valley Indian Reservation encompasses about 23,200 acres in Mendocino County. More than
2194 two thirds of this area is off-reservation trust land. A total of 2,837 acres are allocated as “Available”
2195 under the Round Valley Indian Reserve FMP (Baldwin, Blomstrom, Wilkinson and Associates 2006),
2196 which means that programmed timber harvest may be allowed. As of 2006, there were eight known
2197 pairs of Northern Spotted Owl either nesting, roosting, or foraging on the Reservation. Approximately
2198 80% of the Reservation could be considered as suitable owl habitat, according to the FMP’s
2199 Environmental Assessment (2006). The FMP would impact about 13% of the 22,150 acres of suitable
2200 habitat on the Reservation. Uneven-aged forest management including single-tree and group selection
2201 is the preferred method, with a 20 year cutting cycle and 100 year rotation, although limited even-aged
2202 management is allowed in specific cases. Harvest is expected to be about 3.4 MFB/acre.

2203 **Nonfederal Land**

2204 *History of Timber Management on Nonfederal Lands and the Forest Practice Rules*

2205 The California Department of Forestry and Fire Protection (CAL FIRE; <http://www.calfire.ca.gov/>)
2206 enforces the laws that regulate logging on privately-owned lands in California. These laws are found in
2207 the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will
2208 also preserve and protect California’s fish, wildlife, forests, and streams. Additional rules enacted by the
2209 State Board of Forestry and Fire Protection (BOF) are found in state regulations and are collectively
2210 referred to as the Forest Practice Rules. The purpose of the Forest Practice Rules is to implement the
2211 provisions of the Forest Practice Act in a manner consistent with other laws, including the California
2212 Environmental Quality Act (CEQA) of 1970, the Timberland Productivity Act of 1982, the Porter Cologne
2213 Water Quality Act, and the California Endangered Species Act (CESA).

2214 CAL FIRE ensures that private landowners abide by these laws when harvesting trees. Although there are
2215 specific exemptions in some cases, compliance with the Forest Practice Act and the Forest Practice Rules
2216 apply to all commercial harvesting operations for private landowners from ownerships composed of
2217 small parcels to large timber companies with thousands of acres.

2218 A Timber Harvesting Plan (THP) is generally the environmental review document submitted by
2219 landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the
2220 steps that will be taken to prevent damage to the environment. THPs are prepared by Registered
2221 Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process
2222 substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber
2223 harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

2224 In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by
2225 the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These
2226 biologists would become the first “designated biologists” who would consult on proposed THPs.

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2227 Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules
2228 and procedures that would be adopted in the event of listing. The rules identified descriptions of
2229 Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for
2230 timber operations to avoid take. The rules called for consultations between plan proponents and
2231 Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to
2232 amend the initially adopted emergency rules; amendments to the rules occurred several times as
2233 knowledge of the Northern Spotted Owl increased and with experience gained through implementation
2234 of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and
2235 919.10 [939.10] in March 1991, which describe options and procedures that can be used in THPs to
2236 avoid take of Northern Spotted Owl or to proceed under incidental take authorization.

2237 Section 919.9 [939.9] includes subsections (a) through (g), which are procedures (referred to as
2238 “options”) among which THP submitters must select and then must follow for THPs within the range of
2239 the Northern Spotted Owl or the “Northern Spotted Owl Evaluation Area” as defined in the Forest
2240 Practice Rules, and for THPs that are situated outside of this Evaluation Area that are within 1.3 miles of
2241 known owl activity centers. The option that is selected must meet on-the-ground circumstances. The
2242 information that each option requires is to be used by CAL FIRE to evaluate whether or not the proposed
2243 timber operations under the THP would result in unauthorized Northern Spotted Owl take. Subsections
2244 (a), (b), (c) and (f) involve CAL FIRE consulting with a Spotted Owl Expert (SOE). An SOE is defined in the
2245 Forest Practice Rules as a person with requisite documented education and experience whose
2246 qualifications have been referred by CAL FIRE to USFWS or the Department for evaluation.

2247 Subsection (a) provides the project proponent the option before a THP is filed of requesting an SOE to
2248 complete a preliminary review of the proposed timber operations to evaluate whether Northern
2249 Spotted Owl take would occur. The SOE must apply the criteria for Northern Spotted Owl take avoidance
2250 specified in Section 919.10 [939.10], and must inform the project proponent whether the proposed
2251 timber operations would or would not cause take. In practice, if an SOE concludes take would be
2252 avoided, the results of such a preliminary review would be included in a THP when submitted to CAL
2253 FIRE for filing, review and approval.

2254 Subsection (b) includes a list of information the project proponent must disclose in a THP; including
2255 functional Northern Spotted Owl habitat within and outside the THP area both before and after harvest,
2256 known owl detections, information on owl surveys conducted and results and other information. It
2257 requires a discussion of how functional Northern Spotted Owl habitat will be protected according to
2258 criteria presented in Section 919.10.

2259 Subsection (c) provides the project proponent the option of obtaining from an RPF a certification to be
2260 included in the THP that Northern Spotted Owls are inferred absent from the THP area and out 1.3 miles
2261 from the THP area based on the results of surveys completed according to the USFWS survey protocol,
2262 (USFWS 2012) and the RPF’s personal knowledge and a review of information in the Northern Spotted
2263 Owl database maintained by the Department.

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2264 Subsection (d) involves the project proponent proceeding under the provisions of an incidental take
2265 permit issued by USFWS or the Department.

2266 Subsection (e) allows the project proponent to proceed with timber harvest according to the outcome of
2267 a consultation with USFWS. This outcome is memorialized in what is referred to as a “technical
2268 assistance letter” from USFWS.

2269 Subsection (f) allows the project proponent to disclose in the THP the outcome of an SOE’s preliminary
2270 review as described under Subsection (a), to demonstrate that any measures to avoid Northern Spotted
2271 Owl take recommended by the SOE have been adopted in the THP and that the proposed timber
2272 operations evaluated by the SOE remain substantially the same in the submitted THP.

2273 Subsection (g) is an option appropriate for THPs where one or more Northern Spotted Owl activity
2274 center has been located within the THP area or within 1.3 miles of its boundary. This option requires the
2275 RPF to determine and document activity center-specific protection measures to be applied under the
2276 THP and that various specified forms and acreages of functional owl habitat (nesting, roosting and
2277 foraging) will be retained post-harvest around each activity center. The minimum acreages to be
2278 retained after harvest of functional nesting, roosting and/or foraging habitat within 500 feet, 500 to
2279 1,000 feet, 0.7 mile and 1.3 miles around each activity center are specified in this subsection.

2280 Section 919.10 [939.10] of the Forest Practice Rules presents the criteria CAL FIRE is to apply to
2281 information provided in the THP and during the THP review period to make a finding as to whether or
2282 not the proposed timber operations will avoid Northern Spotted Owl take in the form of “harass, harm,
2283 pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct”, as
2284 defined under Endangered Species Act (ESA). If CAL FIRE concludes take would occur, they must provide
2285 reasons why the determination was made according to criteria presented in section 919.10 [939.10] ,
2286 what information was used in making the determination, and recommend minimum changes to the
2287 proposed THP to avoid take. According to Forest Practice Rules Section 898.2, Special Conditions
2288 Requiring Disapproval of Plans, CAL FIRE shall disapprove a THP if the THP would cause Northern
2289 Spotted Owl take prohibited by the ESA.

2290 Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were
2291 provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following
2292 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could
2293 inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol,
2294 breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly
2295 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans
2296 and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol
2297 was revised (USFWS 2012).

2298 When consultations with the USFWS were required, they consisted of a field review of the proposed
2299 THP area, an evaluation of the pre-harvest and predicted post-harvest habitat typing (its suitability for
2300 nesting, roosting, or foraging), the sufficiency of habitat retained post-harvest within 500 feet, 0.7 mile
2301 and 1.3 mile of owl ACs, and an evaluation of the adequacy of the surveys that were conducted (i.e.

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2302 timing, location, interpretation of results) and their consistency with the USFWS protocol. When
2303 appropriate, the Department designated biologists would evaluate or propose THP-specific habitat and
2304 temporal buffers that differed from standard Forest Practice Rules habitat retention and seasonal
2305 restriction requirements that would be adopted as enforceable conditions of THPs.

2306 In 1991, a curriculum was designed to train private consulting biologists who could conduct the field and
2307 document review portions of a Northern Spotted Owl consultation, although final approval from a
2308 Department designated biologist was still required. University biologists and biological consultants,
2309 along with designated Department Timber Harvest Assessment Program staff helped THP submitters to
2310 evaluate their plans with regard to potential take of Northern Spotted Owls. Workshops helped calibrate
2311 consultants, RPFs and others regarding owl life history, habitat associations, and so forth. Northern
2312 Spotted Owl consultations for most THPs were conducted by the Department designated biologists from
2313 1991 into 1997.

2314 From 1991 through 1997 the Department and to a much lesser extent, CAL FIRE staff processed
2315 Northern Spotted Owl consultations for THPs. Additionally, Department staff participated in the review
2316 of private timber company Habitat Conservation Plans, Spotted Owl Management Plans, and Spotted
2317 Owl Resource Plans. In 1994, Department staff was directed to give Northern Spotted Owl consultations
2318 its highest priority and to set aside a minimum number of days per week to address a consultation
2319 backlog. In this same year, CAL FIRE staff was directed to suspend processing of consultations.

2320 In 1995 the Department established a process for certifying “Private Consulting Biologists” (PCBs) to
2321 fully conduct Northern Spotted Owl consultations, which included approval of a consultation package,
2322 and discontinuing the need for additional approval from a Department designated biologist. However,
2323 Department staff continued to process consultations not prepared or reviewed by PCBs.

2324 Beginning in 1999, Department staff no longer processed THP Northern Spotted Owl consultations and
2325 no longer reviewed the work of private consultant biologists. Reasons for the suspension of processing
2326 included:

- 2327 • Other emerging and compelling forestry sector conservation issues required Department staff’s
2328 attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related
2329 workload).
- 2330 • The Department “Timber Harvest Assessment Program” (later to become the “Timberland
2331 Conservation Planning Program”) budget did not include funding specifically for consultations.
- 2332 • Staffing of USFWS offices with wildlife biologists had increased.
- 2333 • The Department felt CAL FIRE and USFWS staff were capable of review, approval, and
2334 assessment of THPs and NTMPs.
- 2335 • The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- 2336 • The scope, quality and conformance of owl-related information with Forest Practice Rules
2337 requirements appeared to have stabilized after approximately six years of implementation.

2338

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2339 Regardless of the suspension in consultation involvement, the Department continued to evaluate THPs
2340 with regard to potential significant impacts to Northern Spotted Owl from timber operations, and as
2341 appropriate reminded THP proponents to comply with Section 3503.5 of the Fish and Game Code. In
2342 addition, the Department continued monitoring compliance with Northern Spotted Owl-related Habitat
2343 Conservation Plan's conservation measures.

2344 At the time that the Department suspended processing of THP and Nonindustrial Timber Management
2345 Plans (NTMP) consultations (1999), the USFWS technical assistance program began. After nine years of
2346 processing technical assistance requests from applicants, the USFWS notified CAL FIRE in 2008 that
2347 technical assistance requests would have to come directly from CAL FIRE rather than the applicant.
2348 Detailed written guidance and information associated with the analysis process was provided to CAL
2349 FIRE, along with scheduled workshops, to assist in the transition from the USFWS to CAL FIRE (USFWS
2350 2008b). The guidance somewhat deviates from the Forest Practice Rules and included information
2351 needed for Northern Spotted Owl technical assistance, descriptions and appropriate uses for the 1- and
2352 2-year owl survey protocols, owl take avoidance scenarios, and the take avoidance analysis process,
2353 habitat retention criteria within 0.5, 0.7 and 1.3 mile radius from the activity center, and a description of
2354 habitat parameters (i.e., nesting/roosting/foraging habitat) for both the interior and coastal regions.
2355 Since this time, CAL FIRE has been responsible for reviewing the majority of Spotted Owl-affected THPs,
2356 and has assisted applicants and USFWS by assessing technical assistance requests if forwarded to
2357 USFWS.

2358 In 2009, the USFWS developed a white paper, Regulatory and Scientific Basis for the U.S. Fish and
2359 Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in
2360 California's Northern Interior Region, to scientifically justify why the 2008 guidance deviated from the
2361 Forest Practice Rules (USFWS 2009). Specific criteria within the USFWS guidelines, and how they differ
2362 from the Forest Practice Rules, are discussed in the Timber Harvest section below.

2363 The Department Timber Harvest Assessment Program was eliminated in late 2010. From a high of 33
2364 staff members state-wide in 2007, fewer than eight remained engaged in forestry environmental review
2365 and permitting in 2011. The remaining positions were assigned to other programs in the Department,
2366 and in some cases were still involved in a range of forestry-sector work (e.g., lake or streambed
2367 alteration agreements, natural community conservation plans, sustained yield plans and limited THP
2368 environmental review).

2369 In 2013, a new Department "Timberland Conservation Planning Program" (TCP) was established through
2370 a stable funding source and authorities mandated pursuant to Assembly Bill 1492 (2012), to ultimately
2371 increase staff to 41 in Department Headquarters and in four Department Regions. Today, TCP Staff
2372 members participate in THP review, process lake or streambed alteration agreements, complete species
2373 consultations (including "pre-consultations") for "sensitive species" and those that are listed or
2374 candidates for listing pursuant to CESA, review forest habitat restoration grant proposal, and other
2375 activities. In addition, as required by Assembly Bill 1492, TCP staff are mandated to and will soon embark
2376 on inspections of approved and completed THPs and compliance and effectiveness monitoring.
2377 Department staff members selectively review Northern Spotted Owl-related information disclosed in

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THPs as part of routine THP environmental review; however, with the broad suite of other mandated THP review-related responsibilities, the TCP's allocated staffing and resources are not adequate to allow staff to engage in Northern Spotted Owl consultations at the level and in ways they did in the 1990s.

Timber Harvest Management

Timber Harvest Plans

As noted previously, a THP is a document that outlines the level and type of proposed timber harvest, and details steps to be taken to prevent damage to the environment, including measures to avoid take of Northern Spotted Owl. Landowners prepare THPs following the provisions of the Forest Practice Rules, and select options for which to follow (Section 919.9 [939.9], subsections (a) through (g)). The purpose of these options is to avoid take of Northern Spotted Owl.

After reviewing all THPs within the Northern Spotted Owl range submitted to CAL FIRE in 2013, it was apparent that Forest Practice Rules section 919.9[939.9], subsections e and g (hereafter referred to as Option (e) and (g)), were the most frequently used among THPs submitted, and thus, have the greatest potential to impact owl habitat. Other THPs applied Section 919.9/939.9, subsections a, b, and d. Therefore, for THPs submitted in 2013 utilizing Option (e) and (g), we assessed each THP, available through CAL FIRE, for consistency and appropriate application regarding impact avoidance to the Northern Spotted Owl.

For the THPs assessed, proposed silvicultural prescription method and acreage was summarized by county. Silvicultural prescription methods are defined in the Forest Practice Rules, and are included in Appendix 1. In addition, for each THP utilizing Option (e) and (g), the potential impact of proposed harvest to activity centers in each option was assessed as well. Due to the different habitat retention guidance for interior and coastal THPs, the assessment conducted for interior counties were conducted only for THPs associated with activity centers within 1.3 miles of the proposed project, and the assessment for coastal counties included only THPs that were associated with activity centers within 0.7 miles.

Within the range of the Northern Spotted Owl in California, a total of 175 THPs were submitted to CAL FIRE in 2013 from ten counties (Del Norte, Humboldt, Mendocino, Shasta, Siskiyou, Sonoma, Napa, Marin, Tehama, and Trinity counties). Of these, 115 THPs were associated with owl activity centers, encompassing approximately 69,226 acres of proposed harvest on private timberland. Figures 12 and 13 summarize number and percent of THPs submitted from each county on the interior and coastal regions. Of the 115 THPs, 93 were coastal THPs associated with owl activity centers within 0.7 mile, and 22 were interior THPs associated with owl activity centers within 1.3 miles.

Of the 115 THPs associated with owl activity centers, a total of 66 utilized Option (e) (60 coastal and six interior), and 9 utilized Option (g) (two coastal and seven interior) in 2013. Silvicultural prescription methods and associated acres of proposed harvest from the 66 THPs that applied Option (e) in 2013 are summarized in Figure 14. Silvicultural prescription methods and associated acres of proposed harvest

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from the nine THPs that applied Option (g) in 2013 are summarized in Figure 15. Variable Retention prescription was the most utilized method for THPs using Option (e), with nearly 28,000 acres of proposed harvest. Alternative, Clear Cut, and Shelterwood prescriptions were the most utilized method for THPs using Option (g), with 1,413, 714, and 657 acres of proposed harvest, respectively. The number of THPs and the cumulative proposed acres for THPs utilizing Option (e) far surpassed those using Option (g).

Proposed silvicultural prescription methods and harvest amounts within the interior and coastal THPs varied significantly. The dominant methods and acreages for 2013 interior and coastal THPs that used Option (e) and Option (g) and are associated with activity centers are summarized in Table 12. In the interior, the Alternative method was proposed more than any other method, covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total acreage. When the Alternative method is used, the plan must include a description of which silvicultural method is most nearly appropriate or feasible, and must also describe how the Alternative method differs from the most similar method. For plans using the Alternative method in the interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the Alternative method used. Alternative method units typically include a habitat retention area, which can range from 2-10% of the harvest unit. Habitat retention areas usually include hardwoods and/or cavity trees to promote use by wildlife species. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more area than all other methods combined.

Table 12. Silvicultural prescription methods proposed within 1.3 miles of an activity center in interior THPs and within 0.7 miles of an activity center in coastal THPs in 2013.

<u>13 THPs from</u>		<u>62 THPs from</u>	
<u>Interior Counties</u>	<u>Acre</u>	<u>Coastal Counties</u>	<u>Acre</u>
Alternative	9,798	Variable Retention	28,144
Group Selection	2,389	Selection	5,227
Clear Cut	2,257	Group Selection	4,314
Shelterwood Removal	1,574	Transition	3,470
Commercial Thinning	1,335	Seed Tree Removal	1,645
No Harvest Areas	1,015	Clear Cut	1,404
		Rehabilitation	990

To better understand the level of impact of proposed harvest and retention to owl activity centers, each THP utilizing Option (e) and Option (g) in 2013 within the interior and coastal region was assessed further. For 13 interior THPs (six using Option (e) and seven using Option (g)), habitat retention and harvest were assessed at two scales: within 0.5 miles and between 0.5 and 1.3 miles of an activity center. For 62 coastal THPs (60 using Option (e) and two using Option (g)), habitat retention and harvest was only assessed within 0.7 miles of an activity center.

It is important to note that the Forest Practice Rules and USFWS guidance regarding habitat retention vary. As mentioned previously, the Forest Practice Rules outline appropriate retention guidelines to be established within THPs submitted under Option (g). In 2009, the USFWS made recommendations for

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2447 habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat
2448 from Forest Practice Rules guidelines.

2449 Forest Practice Rules guidelines under Option (g) are:

- 2450 • Nesting habitat must be retained within 500 feet of the activity center
- 2451 • Roosting habitat must be retained within 500-1000 feet of the activity center
- 2452 • 500 acres of owl habitat must be provided within 0.7 mile radius of the activity center
- 2453 • 1336 acres of owl habitat must be provided within 1.3 mile radius of the activity center

2454 The USFWS (2009) recommendations are:

- 2455 • No timber removal within 1000 feet of activity center, either inside of outside of the breeding
2456 season
- 2457 • At least 250 acres of nesting/roosting habitat and at least 150 acres of foraging habitat must be
2458 retained within 0.5 mile radius of the activity center
- 2459 • Between 0.5-1.3 mile radius of the activity center at least 655 acres of foraging habitat and 280
2460 acres of low quality foraging habitat must be retained

2461 As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern
2462 Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option
2463 (e) in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2464 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center
2465 once timber harvesting had been completed. For each of the six interior THPs, four primary habitat
2466 types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting
2467 as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option
2468 (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a
2469 given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-
2470 habitat.

2471 Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for
2472 THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior,
2473 and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the
2474 interior (2,117 acres within 0.5 miles and 9,776 acres within 0.5-1.3 miles). On the coast, foraging and
2475 nesting/roosting were retained at relatively similar levels within 0.7 miles (52,817 acres of foraging;
2476 47,344 acres of nesting and roosting).

2477 As noted previously, seven interior THPs and two coastal THPs associated with a total of 14 Northern
2478 Spotted Owl activity centers (8 interior activity centers, and 6 coastal activity centers) utilized Option (g)
2479 in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2480 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center
2481 once timber harvesting had been completed. For each of the seven interior THPs, habitat types were
2482 assessed: low quality foraging, foraging, and nesting and roosting. For the two coastal THPs that utilized
2483 Option (g) a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given

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2484 THP. For these two THPs, three primary habitat types were assessed: foraging, nesting/roosting, and
2485 non-habitat.

2486

2487 **Table 13.** Proposed acres of habitat retention near activity centers from THPs utilizing Option (e) in 2013. Totals
2488 include retention acres for 6 interior THPs and 60 coastal THPs (66 THPs total). Owl habitat is defined as low quality
2489 foraging (LQF), foraging (F), nesting/roosting (NR), high quality nesting/roosting (HQNR), and non-habitat (NH).

	<u>6 Interior THPs associated with 14 activity centers, Option (e)</u>		<u>60 Coastal THPs associated with 132 activity centers, Option (e)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	770	4,702	n/a
F	2,117	9,776	52,817
NR	1,487	6,324	47,344
HQNR	1,649	2,940	n/a
NH	n/a	n/a	31,222

2490

2491 Table 14 summarizes proposed acres of owl habitat retention within the interior and coastal regions for
2492 THPs utilizing Option (g). Total acreages presented are cumulative acres for 7 THPs within the interior,
2493 and 2 THPs within the coast. Within the interior, nesting/roosting and foraging habitat were similarly
2494 proposed for retention, with Low Quality Foraging the least common habitat type retained. Within the
2495 coast, nesting/roosting habitats were retained more than either foraging or non-habitat.

2496

2497 **Table 14.** Proposed acres of habitat retention near activity centers from THPs utilizing Option (g) in 2013. Totals
2498 include retention acres for 7 interior THPs and 2 coastal THPs (9 THPs total). Owl habitat is defined as low quality
2499 foraging (LQF), foraging (F), nesting/roosting (NR), and non-habitat (NH).

	<u>7 Interior THPs associated with 8 activity centers, Option (g)</u>		<u>2 Coastal THPs associated with 6 activity centers, Option (g)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	612	3,004	n/a
F	1,032	3,171	1,548
NR	1,388	3,879	2,763
NH	n/a	n/a	1,597

2500

2501 Over time, activity centers may be cumulatively impacted by timber management activities. Through the
2502 use of Option (e) and Option (g), habitat retention and harvest for interior THPs from 2013 were
2503 typically assessed within 0.5 miles and between 0.5 and 1.3 miles of an activity center; whereas for
2504 coastal THPs from 2013 habitat retention and harvest were assessed primarily within 0.7 miles of an
2505 activity center. The 0.5 mile and 0.7 mile radius around activity centers is meant to capture the core
2506 habitat use of Spotted Owls within their home range, whereas the 1.3 mile radius is meant to capture

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2507 the broader home range. Therefore timber harvest within these radii has a potential to impact quality
2508 and extent of owl habitat, and consequently, owl fitness. As discussed previously, to mediate this loss
2509 the Forest Practice Rules set limits on the amount and type of habitat that may be harvested within
2510 certain radii. Since timber growth is slow, and consequently, regrowth of owl habitat is slow, it is
2511 important to understand the cumulative impact to activity centers over time.

2512 To consider the risk of habitat removal to individual activity centers, the amount of habitat proposed for
2513 harvest was calculated for activity centers addressed in THPs utilizing Option (e) and Option (g) over
2514 various periods in time between 1986 and 2013 (Tables 15 and 16). The activity centers evaluated were
2515 selected from those that were associated with THPs submitted in 2013; these activity centers were
2516 evaluated over time by evaluating all THPs associated with these activity centers in past harvest history.
2517 The sample selected for evaluation did not include all of the activity centers associated with THPs in
2518 2013, only a subset. Activity centers were chosen from all counties associated to provide results on a
2519 broad scale. An approximately even number of activity centers were chosen from each county. At the
2520 proposed levels of harvest noted in the THPs, it is apparent that some activity centers have experienced
2521 extensive habitat removal or modification over time. Of the 17 activity centers evaluated in the interior,
2522 six activity centers have experienced greater than 2,000 acres timber harvest cumulatively over time
2523 within the 1.3 mile radius (~3,400 acres) home range, and six activity centers have experienced greater
2524 than 250 acres timber harvest within the 0.5 mile radius (~500 acres) core range. Of the 14 activity
2525 centers evaluated on the coast, six activity centers experienced harvest of over 500 acres, cumulatively,
2526 within the 0.7 mile radius (~985 acres) core range, with two of these over 1,000 acres. Appendix 3
2527 includes bar graphs for each activity center within the coast and interior, and depicts level of harvest
2528 within 0.5, 0.7, and 1.3 mile radii from the activity center.

2529 It is reasonable to assume that high levels of harvest, such as shown for some activity centers in Table 15
2530 and 16, can negatively impact Northern Spotted Owls. Although no study has been conducted
2531 specifically linking the amount of harvest within the 0.5, 0.7, and 1.3 mile radius of an activity center to
2532 impacts on owl fitness (e.g., reproductive rate, survival, etc.), several research studies have
2533 demonstrated a link between owl fitness and amount of habitat, structural characteristics, and spatial
2534 configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007). These studies
2535 are discussed in more depth above in the Habitat Requirements section (Habitat Effects on Survival and
2536 Reproduction) and below in the Habitat Loss and Degradation threat section of this document. Through
2537 comparison of Northern Spotted Owl territory loss on private and federal lands, the USFWS (2009)
2538 suggests that the Forest Practice Rules have not been entirely effective in preventing cumulative loss of
2539 important owl habitat surrounding activity centers associated with repeated harvest. Details regarding
2540 the USFWS analysis can be found in the Regulatory Mechanisms Consideration section of this document.

2541

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Table 15. Proposed timber harvest (in acres) within interior THPs utilizing Option (e) and Option (g) over time (range 1997-2013), showing level of harvest within 0.5 miles and between 0.5-1.3 miles of activity centers. The activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by evaluating all THPs associated with these activity centers since 1997.

Activity Center	Range of Harvest Years	Interior, Option (e) Acres harvested		Interior, Option (g) Acres harvested	
		0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)	0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)
SIS0492	2004-2013	0	915	x	x
SIS0554	1998-2004	102	589	x	x
TEH0030	1998-2013	381	2,554	x	x
TEH0037	1998-2013	379	2,221	x	x
TEH0038	1998-2013	151	1,002	x	x
TEH0072	1998-2013	476	1,954	x	x
TEH0075	1997-2004	277	2,530	x	x
TEH0087	1998-2013	291	2,137	x	x
TEH0101	1997-2013	168	2,113	x	x
TEH0114	2002	0	8	x	x
TEH0117	2006-2013	37	1,123	x	x
SHA0024	2003-2005	x	x	41	239
SHA0037	1998-2013	x	x	0	426
SHA0106	2000-2013	x	x	21	160
SIS0319	1997-2013	x	x	31	1,505
TRI0169	2000-2013	x	x	0	118
TRI0316	1997-2013	x	x	251	495

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Table 16. Proposed timber harvest (in acres) within coastal THPs utilizing Option (e) and Option (g) over time (range 1986-2013), showing level of harvest within 0.7 miles of activity centers. The activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by evaluating all THPs associated with these activity centers since 1986.

Activity Center	Range of Harvest Years	Coast, Option (e) Acres harvested within 0.7 mile radius (~985 acre core area)	Coast, Option (g) Acres harvested within 0.7 mile radius (~985 acre core area)
HUM0058	2011-2013	30	x
HUM0400	1990-2013	510	x
HUM0622	1993-2013	798	x
HUM0791	1999-2013	270	x
HUM0986	1997-2013	162	x
MEN0146	1994-2013	1,180	x
MEN0309	1987-2013	565	x
MEN0370	1992-2010	413	x
HUM0097	1996-2013	x	345
HUM0098	2004-2005	x	67
HUM0308	1996-2013	x	226
HUM0442	2004-2013	x	227
MEN0082	1986-2013	x	1,316
MEN0114	1987-2013	x	829

Nonindustrial Timber Management Plans

In 1989, the Legislature added language to the Forest Practice Act creating provisions to include Nonindustrial Timber Management Plans (NTMPs) to promote long term management and planning on forest ownerships of 2,500 acres or less (Pub. Resources Code §4593 et seq.). Private forestlands are generally classified into non-industrial and industrial ownerships based on acreage and association with industrial uses. Non-industrial private forest (NIPF) owners typically have less than 5,000 acres of forestland and do not own a mill. Of the private forestlands in California, NIPF owners collectively hold about 3.2 million acres (41%), with the balance being held by industrial forest landowners.

The NTMP allows smaller NIPF timberland owners to prepare a long-term management plan that reduces regulatory time and expense by providing an alternative to submitting individual THPs prior to harvest. Landowners agree to manage their forests through uneven-aged management and long-term sustained yield, in exchange for a higher degree of regulatory surety. “Sustained yield” means the yield of commercial wood that an area of commercial timberland can produce continuously at a given intensity of management consistent with required environmental protection and which is professionally planned to achieve over time a balance between growth and removal (Pub. Resources Code, § 4593.2, subd. (d); Forest Practice Rules, § 895.1). Timberland owners operating under an NTMP are also protected under provisions of Public Resources Code section §4593, which offers landowners exemption

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2571 from applying subsequent rule changes to Forest Practice Rules to their project; however, this does not
2572 mean that a NTMP will never be subject to new laws or regulations.

2573 Public Resources Code section §4594 subdivision (h) requires RPFs to submit a Notice of Operations
2574 (NTO) prior to harvest that specifies that the NTMP will implement best management practices for the
2575 protection of water, soil stability, forest productivity, and wildlife, as required by the current rules of the
2576 Board, or is consistent with the original plan and will not result in any significant degradation to the
2577 beneficial uses of water, soil stability, forest productivity or wildlife. Required applications and
2578 administration of NTMPs are detailed in the Forest Practice Rules commencing with section 1090.
2579 Landowners submitting proposed NTO's subsequent to requirements of Forest Practice Rules, section
2580 919.9 [939.9] subdivisions (a) through (g), are expected to either contain specific measures that fulfill
2581 these requirements or best management practices equivalent to such provisions. These options have
2582 resulted in variable and diverse Northern Spotted Owl protection measures within NTMPs; however,
2583 Options (e) and (g) are the most commonly used options. As stated previously, Option (e) allows
2584 landowners to submit a technical assistance letter to the USFWS for approval. Under Option (g), the
2585 landowner must supply the location of activity centers located within the plan boundary or within 1.3
2586 miles of the boundary.

2587 NTMP prevalence has grown steadily since its inception. Table 17 summarizes the approaches
2588 landowners took to protect comply with Forest Practice Rules in avoiding take of Northern Spotted Owl
2589 through NTMPs over time, including numbers of NTMPs within 1.3 miles of an activity center and the
2590 those NTMPs utilizing Option (e) and Option (g) over 1991-2014 for the interior forests, and 2005-2014
2591 for the coastal forests. A total of 157 NTMPs were evaluated within the range of the Northern Spotted
2592 Owl: 35 from the interior portion of the range that were submitted from 1991-2014, and 122 from the
2593 coastal portion of the range that were submitted from 2005-2014. It should be noted that the majority
2594 of NTMPs on the coast were submitted prior to 2005 (418 NTMPs in 1991-2004 versus 122 NTMPs in
2595 2005-2014). However time did not allow full review of that time period for coastal NTMPs. Of the 157
2596 NTMPs evaluated, 115 are within 1.3 miles an owl activity center. Option (e) and Option (g) were applied
2597 in 114 and 14 NTMPs, respectively.

2598 During 1991 through 2014 35 NTMPs have been approved for landowners in the interior portion of the
2599 Northern Spotted Owl range (Siskiyou, Trinity, Shasta, and Tehama counties), with 10 plans utilizing
2600 Option (e), 10 plans utilizing Option (g) and the remainder using another option. Of the 35 NTMPs, 19
2601 (54%) were associated with at least one Northern Spotted Owl activity center within 1.3 miles of the
2602 plan boundary. The coastal portion of the range (Humboldt, Mendocino, Sonoma, Lake, and Napa
2603 counties) saw substantially more NTMPs within a shorter time frame. From 2005 to 2014, 122 NTMPs
2604 were submitted and approved. Although Del Norte County is part of the owl's range, no NTMPs were
2605 submitted during this time frame. Of the 122 NTMPs evaluated, 96 (78%) were associated with at least
2606 one activity center within 1.3 miles of the plan boundary. Of these, the majority (104 NTMPs) utilized
2607 Option (e) (i.e., USFWS technical assistance letter); therefore, the USFWS has been instrumental in
2608 providing consultation and guidance to NTMPs submitters as it relates to protection measures for
2609 Northern Spotted Owl and their habitat.

Comment [A61]: Note to external reviewers:
We are currently working to get all coastal NTMPs (1991-2014) summarized in the table. This will be included in the next version. In addition, number of ACs associated with the NTMPs will be added for all counties.

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2610 **Table 17.** Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years
2611 2005-2014 for plans in Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	NTMPs in NSO Range	NTMPs within 1.3 miles of NSO	NTMPs that implemented 939.9 (e)	NTMPs that implemented 939.9 (g)	NTMPs that used other options
<i>Interior Counties 1991-2014</i>					
Siskiyou	16	13	6	7	1
Trinity	6	3	2	2	0
Shasta	11	3	2	1	0
Tehama	2	0	0	0	2
Interior Subtotal	35	19	10	10	3
<i>Coastal Counties 2005-2014</i>					
Humboldt	41	40	38	2	0
Mendocino	58	45	43	2	0
Sonoma	19	9	19	0	0
Lake	3	1	3	0	0
Napa	1	1	1	0	0
Coastal Subtotal	122	96	104	4	0
Total	157	115	114	14	3

2612

2613

2614 For NTMPs in Siskiyou, Trinity, and Shasta counties measures were analyzed for proposed silvicultural
2615 prescription methods for years 1991-2014, and for years 2005-2014 in Humboldt, Mendocino, Sonoma,
2616 Lake, and Napa counties (Table 18). Only NTMPs that occurred within 1.3 miles of a Northern Spotted
2617 Owl activity center were included in this analysis; therefore, Tehama NTMPs have been excluded.
2618 Silvicultural prescription methods noted in Table 18 are those most often proposed within the NTMPs
2619 analyzed. Other prescriptions proposed but not included in Table 18 include Road Right of Way,
2620 Sanitation Salvage, Special Treatment, Fuel break, and Variable Retention, and is inclusive of 747
2621 cumulative acres.

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Table 18. Acres proposed for harvest under NTMPs within 1.3 miles of a Northern Spotted Owl activity center for various silvicultural prescriptions. NTMPs are from years 1991-2014 for Siskiyou, Trinity, and Shasta counties, and 2005-2014 for Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	Selection	Group Selection	Uneven-aged	Commercial Thinning	Non-Timberland Area	Transition	Rehabilitation of under-stocked
<i>Interior Counties 1991-2014</i>							
Siskiyou	2597	60	1127	251	22	251	251
Trinity	2783	237	653	0	0	0	0
Shasta	1609	1036	2276	273	463	0	0
Interior Subtotal	6989	1333	4056	524	485	251	251
<i>Coastal Counties 2005-2014</i>							
Humboldt	2322	6139	0	35	424	1101	1658
Mendocino	4561	1926	0	0	419	975	71
Sonoma	547	4603	0	0	127	245	246
Lake	45	587	0	0	0	0	0
Napa	0	683	0	0	17	0	0
Napa-Lake	1858	0	0	0	0	0	0
Coastal Subtotal	9333	13938	0	35	987	2321	1975
Total	16322	15271	4056	559	1472	2572	2226

Of the NTMPs included in this analysis, a total of 42,478 acres were proposed for harvest within 1.3 miles of an activity center. Selection, Group Selection, and Uneven-aged silvicultural methods are the most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection, Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Most plans that used the Uneven-aged silvicultural method did not delineate acres that would fall under each category. For NTMPs submitted on the interior from 1991-2014, Selection, Group Selection, and Uneven-aged totaled 6,989, 1,333, and 4,056 acres, respectively. For NTMP submitted from 2005-2014 on the coast, Selection and Group Selection totaled 9,333 and 13,938 acres, respectively. Cumulatively, these more common silvicultural methods equates to 29% (12379/42478) of the total acres proposed for harvest

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2636 under interior NTMPs analyzed, and 55% (23271/42478) of the total acres proposed for harvest under
2637 coastal NTMPs analyzed.

2638 The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl
2639 habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear
2640 that some information was not available to the reviewer due to the nature of the older NTMP
2641 narratives, limited public information, and subsequent amendment submissions. There is simply no
2642 effective way to track this information in an analysis going back in time. Though Selection and Group
2643 Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range,
2644 we can infer that owl habitat is retained to some extent; however, we could not determine the type or
2645 quality of habitat retained. For instance, high quality nesting and roosting habitat may be harvested
2646 more frequently, thereby reducing owl fitness.

2647 Spotted Owl Management Plans

2648
2649 A Spotted Owl Management Plan (SOMP) details measures to avoid take of Northern Spotted Owl as a
2650 result of timber harvest operations on privately owned land. SOMP are developed cooperatively
2651 between USFWS and a private land owner, and can be used to streamline the review of THPs. SOMP
2652 follow the procedures in Forest Practice Rules section 939.9 subdivision (e) and include:

- 2653 • a description of the area covered
2654 • protection measures for breeding or nesting Northern Spotted Owls
2655 • habitat definitions, and
2656 • habitat quality and quantity retention requirements

2657
2658 SOMP are contain expiration dates upon which USFWS and land owners meet to review and revise the
2659 document as necessary; however, incorporation of new scientific information may occur at any time
2660 during the lifetime of the SOMP. SOMP differ from the standard no-take measures provided in the
2661 Forest Practice Rules in that they utilize site-specific information in conjunction with research to develop
2662 strategies to avoid take over a period of years. The most notable difference between SOMP no-take
2663 requirements and those in the standard Forest Practice Rules section is the primarily survey area
2664 required and possibly habitat required post-harvest. Survey areas may be reduced as a result of local
2665 information collected over a number of years. Post-harvest habitat requirements may also be greatly
2666 reduced or increased based on site specific local information.

2667 Three SOMP are currently being used in the THP process in California. Two of these were reviewed for
2668 this assessment by the Department, totaling 175,700 acres in Siskiyou, Trinity and Shasta Counties. The
2669 Department never received a copy of the third SOMP, located in Mendocino County; therefore we are
2670 unable to discuss it here. Both documents reviewed included the elements listed above, and were
2671 developed with the USFWS considering site-specific information for those properties. Within the SOMP
2672 reviewed, suitable habitat definitions were developed specifically for the ownership(s) utilizing the
2673 SOMP. These habitat definitions are developed using information from the property and may be
2674 different from those suitable habitat definitions in survey protocols or other rules or regulations.

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2675 It is not known if the long-term use of SOMP on private lands in California is limiting Northern Spotted
2676 Owl populations, but all operations conducted under a SOMP occur within the known range of Northern
2677 Spotted Owl and usually within suitable owl habitat. More information is needed to fully understand the
2678 effects of SOMP on Northern Spotted Owls.

2679 Spotted Owl Resource Plans

2680

2681 A Spotted Owl Resource Plan (SORP) is intended to offer landowners submitting THPs a programmatic
2682 approach to avoid take of Northern Spotted Owl. SORPs are addressed in Forest Practice Rules section
2683 919.9 subdivision (a), and is defined as, "...an approach to preventing a taking of the northern Spotted
2684 Owl while conducting timber operations [,]" and "...necessarily involves more than one timber harvest
2685 plan." SORPs do not differ significantly from the required habitat retention guidelines found in the
2686 Forest Practice Rules section 919.9 subdivision (g), and mainly provide a programmatic method for
2687 Northern Spotted Owl protection. A description of the area covered, protection measures for breeding
2688 or nesting Northern Spotted Owls, habitat definitions, survey areas and habitat quality and quantity
2689 retention requirements are all provided within a SORP. A SORP may be submitted to CAL FIRE for
2690 preliminary review, and once approved, can be attached to individual THPs submitted by a landowner
2691 under Forest Practice Rules section 919.9 subdivision (a). The THP is reviewed by the Department, but
2692 not necessarily the SORP.

2693 A total of three SORPs have been approved and are being utilized in the THP process in California, and a
2694 fourth SORP is being prepared. The three approved SORPs cover a total of 358,202 acres. All three
2695 SORPs use a combination of no-take language from Forest Practice Rules section 939.9, along with site-
2696 specific information to develop no-take requirements. No specific habitat definitions were developed for
2697 SORPs, and thus, either standard habitat definitions from the Forest Practice Rules or standard habitat
2698 definitions from the USFWS are used within the plans. The site-specific information is used mostly for
2699 protocol survey areas and noise disturbance buffer distances, and is usually developed from historical
2700 survey records and independent noise level studies.

2701 It is not known if the long-term use of SORPs on private lands in California is limiting Northern Spotted
2702 Owl populations, but all operations conducted under a SORP occur within the known range of Northern
2703 Spotted Owl usually are within suitable owl habitat. More information may be needed to fully
2704 understand the effects of SORPs on Northern Spotted Owls.

2705 Habitat Conservation Plans

2706

2707 Under Section 10(a) of the ESA incidental take, defined as take that is incidental to and not the purpose
2708 of the carrying out of an otherwise lawful activity, may be authorized for federally threatened and
2709 endangered species via a Habitat Conservation Plan (HCP). California's Natural Community Conservation
2710 Planning Act of 1991 takes a broader approach than either CESA or ESA. A Natural Community
2711 Conservation Plan (NCCP) identifies and provides for the protection of plants, animals, and their
2712 habitats, while allowing compatible and appropriate economic activity. HCPs and NCCPs are both long-
2713 term landscape level conservation plans that allow harvest of Northern Spotted Owl habitat, which
2714 could result in a specified level of incidental take of owls within the plan area. Generally, these plans

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require historic and occupied Northern Spotted Owl activity centers to be monitored to ensure a healthy and stable population, suitable foraging, and nesting habitat to be maintained or created, and activities to be adjusted accordingly using an adaptive management approach.

Five HCPs that include Northern Spotted Owl as a covered species have been issued in California (Table 19). One plan, on Mendocino Redwood Company land, is in the development process and will be a combination HCP and NCCP. Each of these plans is described in more detail below.

Table 19. Current and planned HCPs/NCCPs in California that include Northern Spotted Owl as a covered species.

Plan Title	Location	Date Permit Issued	Term
Green Diamond Resource Company California Timberlands & Northern Spotted Owl HCP	Humboldt, Del Norte, Trinity Counties	09/17/1992	30 years
Regali Estates HCP	Humboldt County	08/30/1995	20 years
Humboldt Redwood Company HCP	Humboldt County	03/01/1999	50 years
Terra Springs LLC HCP	Napa County	03/03/2004	30 years
Fruit Growers Supply Company HCP	Siskiyou, Shasta, and Trinity Counties	11/27/2012*	50 years
Mendocino Redwood Company HCP/NCCP	Mendocino County	No permits issued	80 years

*A recent court decision in April 2015 determined the Fruit Growers Supply Company HCP to be invalid.

Green Diamond Resource Company Northern Spotted Owl HCP

Green Diamond Resource Company (GDRC) inherited the existing Northern Spotted Owl HCP when they acquired Simpson Timber Company (STC 1992). The HCP has a 30-year term, which expires September 17, 2022, and calls for a full review at the end of 10 years of implementation. GDRC owns approximately 383,100 acres of forestland in California within the Northern Spotted Owl range, mostly within Del Norte and Humboldt counties, with only small portions in Mendocino and Trinity counties, and is located within the California Coast Province. Of the 383,100 acres, 86% are conifer forests comprising two dominant species, coastal redwood, and Douglas-fir. Since most of the conifer forests have been harvested over the last several decades, second-growth makes up all but a small fraction. Residual areas of old-growth forests (logged in the early 1940s and 1960s) make up less than 3%, and are concentrated in the more inland portions of GDRC ownership. Forested areas never logged (virgin old-growth) are scattered throughout the land ownership and consist of 150 acres of redwood and 300 acres of Douglas-fir, comprising less than 2% of GDRC land. Hardwood forests (oak species, madrone, alder) comprise 8%, and non-forest (grassland, wetland, rock and river bars) 6%. As of 1991, just prior to issuance of the HCP, 146 ACs were known to occur on GDRC lands. Density of owls was much higher in the southern portions of land ownership, than the northern portion (1.2 owls/mi² and 0.32 owls/mi², respectively).

During development, the HCP prepared a 30-year age-class forecast model to determine how much habitat would be available to owls over time, and developed a predictive habitat (nesting mosaic) model to estimate nesting habitat on the GDRC land ownership. The age-class forecast covered 1991 through 2021, and assumed timber harvest would occur at an annual rate of 3,000-6,000 acres. Results indicated

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2745 that second-growth stands in the 46+ year age-class would more than double, the 31-45 year age-class
2746 would increase by approximately 50,000 acres in first 10 years then return to 1991 levels, and the 8-30
2747 year age-class would generally decrease over time. The nesting mosaic model was designed to
2748 determine the mosaics of habitat types associated with owl activity centers and utilized the 1991 cover
2749 types and age-classes. Results initially indicated 158,477 acres of GDRC land fit the nesting mosaic
2750 profile, with the number of ACs in 2021 would be roughly the same as the 1991 level.

2751 The level of take (via owl displacement and habitat modification) was estimated at 3 pairs per year over
2752 first 10 years through direct habitat modification (habitat removal within owl sites), and 2 owls per year
2753 over first 10 years via indirect displacement (habitat removal in adjacent stands to owl sites).
2754 Conservation measures were developed to avoid or minimize the likelihood of take, and include:

- 2755 • Habitat management and nest site protection. Implementation will protect nest sites during
2756 breeding and fledging periods, maintain foraging, roosting and nesting habitat, and accelerate
2757 growth of replacement stands. Stands to be harvested March through August will be surveyed
2758 for Spotted Owls before entering area, as well as a 1,000 ft buffer around the area planned for
2759 harvest. Just prior to harvest, up to three more surveys will be conducted. Nest trees will be
2760 marked and no timber harvest is to be conducted within a 0.25 mile radius until after young
2761 have fledged or the nest fails, and a 500 ft radius after fledging until the young disperse.
2762 Valuable land resources for Spotted Owls will be retained on the landscape, such as
2763 hardwood/conifer patches, habitat along watercourses, snags, standing live culls, and brush.
- 2764 • Development of a research program. A research program consists of ongoing owl surveys,
2765 banding owls, monitoring reproductive success, identifying important nest site attributes, and
2766 assessing abundance and distribution.
- 2767 • Development of habitat area to be set-aside. Thirty-nine habitat set-asides were identified in
2768 which timber harvest would not occur. The total acreage of these set asides is 13,242.5 acres
2769 and, as of HCP issuance, 39 owl sites. A 0.25 mile or 500 foot buffers are placed around sites to
2770 ensure timber removal or other associated harvest activities adjacent to set-asides to not impact
2771 owl sites within. Set-asides were monitored annually.
- 2772 • Staff training. A program was developed to properly train GDRC employees and contractors to
2773 monitor owls and collect data.

2774
2775 The trigger for any course correction required during the HCP term will be if the reproductive rate falls
2776 below the rate of the Willow Creek Study Area (WCSA) for three consecutive years. The WCSA was a
2777 good comparison at the time due to its proximity to GDRC and its unique long-term Spotted Owl
2778 dataset. Since 1993, comparisons of reproductive rates at GDRC and WCSA show that the study area
2779 with higher annual reproductive rate often shifts between the two areas. There have not been three
2780 consecutive years with statistically significant results showing the reproductive rate at GDRC falling
2781 below that at WCSA (GDRC 2015).

2782 According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was
2783 happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the

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2784 understanding of suitable owl habitat was limited. In 2006, GDRC submitted an application to the
2785 USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was
2786 issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes
2787 the Project, requires the Applicant to comply with terms of the amended BO and its associated
2788 incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified
2789 the Department that the BO was issued and requested that the Department issue a consistency
2790 determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1.
2791 In January 2014, the Department found that BO, its related ITS and ITP, and the HCP were consistent
2792 with CESA and meet the conditions set forth in Fish and Game Code section 2081 for authorizing
2793 incidental take of CESA-listed species (CDFW 2014a).

2794 The Department found that the mitigation measures identified in the amended ITP and HCP will
2795 minimize and fully mitigate the impacts of take and the continued existence of Northern Spotted Owl
2796 will not be compromised. Measures in the amended versions include, but are not limited to:

- 2797 • Maintaining a 20,310 acres “Special Management Area” in Upper Mad River area where Spotted
2798 Owls may not be taken.
- 2799 • Survey for Spotted Owls in each area where timber harvest is planned, and delay harvest of nest
2800 site and primary activity centers in after the breeding season.
- 2801 • Maintain records of surveys and actual take and notify the USFWS events such as direct harm to
2802 owls, catastrophic events that destroy owl sites, shifts in distribution, accidental death, or injury
2803 of owls, and the finding of dead or injured owls.
- 2804 • Continue gathering data on owl behavior and habitat needs, and update GIS database regularly.
- 2805 • Establish 39 set-asides that represent 13, 252 acres in which timber harvest is not allowed.
- 2806 • Retain, where feasible, resources values that would provide future owl habitat.
- 2807 • Comply, where feasible, with “Overall Resource Management” measures specified in the HCP,
2808 including retention of canopy cover, ground cover, habitat along streams, and a variety of tree
2809 sizes and species within WLPZs.
- 2810 • Implement research on habitat overlap and interactions between Spotted Owls and Barred
2811 Owls.
- 2812 • Conduct surveys according to approved Spotted Owl protocol that accounts for occupancy and
2813 Barred Owl presence, and contact the USFWS for direction as appropriate.
- 2814 • Prepare annual report to record actual instances and number of Spotted Owl sites displaced,
2815 level of habitat loss within owl sites, actual and estimated levels of displacement of past year,
2816 estimated levels of displacement for future year, estimate number of owl sites and amount of
2817 owl habitat, pre- and post-harvest estimates of snags and residual trees in THP areas, results of
2818 nest and set-aside monitoring, and assess efficacy of measures to date.
- 2819 • Provide Department with letter to document financial assurances for HCP implementation.
- 2820

2821 The last annual report (GDRC 2015) described survey results for September 2013 through August 2014
2822 and met the reporting requirements noted above. Since 1992, there has been an overall increase in the

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total amount of Northern Spotted Owl habitat, indicating that growth of forest stands into owl habitat surpassed forested stands impacted by timber harvest. The primary form of incidental take anticipated in the HCP is the displacement of owls due to modification of owl habitat. It was recognized that such displacement could impair essential behavioral patterns and result in actual death or injury to owls. Rather than examining the circumstances of each case to determine whether a take as defined in the ESA had in fact resulted from Green Diamond's habitat modification, the implementation agreement calls for reporting as a "displacement" any instance where an owl site itself is harvested or habitat around an owl site is reduced below thresholds established in the HCP. Each displacement is originally reported on the basis of harvest activity in relation to an owl site within a particular home range; however owls that were recorded as displaced can be removed from the cumulative total if minimum occupancy and nesting criteria are met in the years post-harvest. Based on displacement removal criteria, 33 owls that were recorded as displacements (based on harvest activity) have been removed from the cumulative total (i.e., they are not considered displaced under terms of the HCP). Green Diamond's incidental take permit allows 58 owl pairs to be taken during the 30 year term of the HCP. Although the number of reported displacements per year has been variable, the average is approximately three owl sites per year, leading to 47 owls displaced since 1993 (GDRC 2015).

Regali Estates HCP

This HCP covers 480 acres in Humboldt County, southeast of the town of Ferndale, and is located within the California Coast Province (Regali Estate 1995). Its 20-year term expires August 30, 2015. The plan covered two Northern Spotted Owl activity centers, and contains white-fir, Sitka spruce, redwood, young tree plantations, grassland, and agriculture. The harvest of conifer species resulted in the immediate loss of nesting habitat for one pair. Due to its small size, take afforded by the plan was not deemed to impact regional Spotted Owl populations. Measures set for the plan included: (1) Retention of habitat around nest sites; (2) No harvest impact for a portion of the covered area; (3) Retention of foraging habitat in harvested areas; (4) Salvage of only commercially valuable dead and dying trees; (5) Planting of conifer trees in open grassland habitat; (6) Retention of slash piles for prey habitat; (7) Monitoring of owls; and (8) Completion of biannual reports.

Humboldt Redwood Company HCP

The HRC HCP covers 211,700 acres of coast redwood and Douglas-fir forest in Humboldt County, and is located within the California Coast Province (HRC 2014). Currently the Plan Area contains approximately 208 Northern Spotted Owl activity centers. The term is 50 years, which means the plan will expire March 1, 2049. The primary covered activity is timber management (timber harvest and regeneration, site preparation, planting, vegetation management, thinning, and fire suppression) occurring on approximately 203,000 acres. The HCP requires ongoing monitoring and reporting to ensure that the conservation measures being implemented are accomplishing the desired outcomes. Through the adaptive management process, the monitoring results were used to develop an updated HCP on March 31, 2014.

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2860 The overall strategy in the Northern Spotted Owl conservation plan, detailed in the HCP, is to (1)
2861 minimize disturbance to Northern Spotted Owl activity sites, (2) monitor to determine whether these
2862 efforts maintain a high-density and productive population of owls on the ownership, and (3) apply
2863 adaptive management techniques when new information on owl biology/ecology is available and to best
2864 assess the performance of management objectives. Specific habitat retention requirements are
2865 provided to conserve habitat for nesting, roosting, and foraging owls.

2866 Northern Spotted Owl management objective outlined in the plan include:

2867
2868

1. Maintain a minimum of 108 activity centers each year over the life of the HCP.
2. Maintain Northern Spotted Owl pairs on an average of 80 percent (over a five-year period) of the minimum 108 activity centers on the ownership. At least 80 of these sites shall be “Level One” sites, and the balance shall be “Level Two” sites.
3. Maintain an average reproductive rate of at least 0.61 fledged young per pair (over a five-year period) for the minimum of 108 activity centers on the ownership.
4. During the first five years of the HCP, maintain and document the minimum number of activity centers designated in the HCP.

2876 Northern Spotted Owl conservation measures outlined in the plan include:

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1. Establish a Northern Spotted Owl Scientific Review Panel to review and make recommendations for monitoring techniques, offer expert review of monitoring results, and make recommendations on habitat retention standards for maintenance and recruitment of activity centers.

2882 2. Conduct a complete annual censuses (or and approved sampling methodology) to monitor all
2883 activity centers on the ownership and to determine numbers of pairs, nesting pairs, and
2884 reproductive rates.

2885 3. If activities are initiated before February 21 and are maintained continuously past the onset of
2886 the breeding season (March 1 through August 31) the THP and a 1,000 foot buffer is to be
2887 surveyed, with timing and number of surveys dependent on when activities are to occur within
2888 the breeding season. For site preparation activities initiated between March 1 and May 31 site
2889 visits will be conducted based on known activity centers within 1,000 feet of activity. Details on
2890 how and when site visits are to occur are site specific. No surveys required if timber operations
2891 occur only outside the breeding season.

2892 4. Before June 1 each year, at least 80 activity sites shall be maintained using the habitat retention
2893 guidelines detailed in the HCP, referred to as “Level One” habitat retention. Activity sites
2894 selected for “Level One” retention must have supported owls in the previous year and must also
2895 be active for the year in which the site is selected. If a site is determined to be nesting, no
2896 harvesting shall occur during the breeding season within a 1,000-foot radius of the nest tree.

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- 2897 Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the
2898 activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting
2899 habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable
2900 owl habitat must be provided, if present, and less than 50 percent of this shall be under
2901 operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided,
2902 within 1.3 miles of each activity center.
- 2903 5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of
2904 each year to make up the minimum number of activity centers designated by the HCP. “Level
2905 Two” habitat retention must be active for the year in which the site is selected. If a site is
2906 determined to be nesting, no harvesting shall occur during the breeding season within a 1,000-
2907 foot radius of the nest tree. Following the breeding season, 18 acres around the AC shall be
2908 maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC
2909 must be in place. For sites, which have been determined to be occupied by a non-nesting pair
2910 or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if
2911 present, and a 400 foot radius buffer protecting the activity center must be in place. Harvesting
2912 of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat
2913 retention area.
- 2914 6. Activity center that are not needed to meet management objectives above shall receive “Level
2915 Three” protection measures. These activity centers shall have a 1,000-foot buffer during the
2916 breeding season. Timber harvest associated may occur before March 1 or after August 31.
2917 During the breeding season, for activity centers which have been determined to be occupied by
2918 a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as
2919 suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur
2920 during the breeding season in the area adjoining the 18-acre habitat retention area.
- 2921 7. All nest trees shall be marked and be retained if the activity center is harvested.
- 2922 The HCP outlines an objective to conserve habitat diversity and structural components within the plan
2923 area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types
2924 and seral stages are maintained across the landscape over the permit period, as well as structural
2925 components, to contribute to the maintenance of wildlife species covered under the plan, including the
2926 Northern Spotted Owl.
- 2927 Structural components to be retained include:
- 2928 1. A certain number and size snags that do not pose a human safety hazard.
- 2929 2. A certain number and size of green replacement trees, if snags are not present, with a priority
2930 for trees other than redwood.

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- 2931 3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority
2932 given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or
2933 cavities.
- 2934 4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a
2935 maximum of two per acre.
- 2936 5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given
2937 to logs over 30 inches in diameter.
- 2938 In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that
2939 the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section
2940 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in
2941 fact consistent with CESA and meet the conditions set forth in Fish and Game Code section 2081 for
2942 authorizing incidental take of CESA-listed species (CDFW 2014b).
- 2943 The Department found that the mitigation measures identified in the amended ITP and HCP will
2944 minimize, will fully mitigate the impacts of take and will not compromise the continued existence of
2945 Northern Spotted Owl. Measures in the amended versions include, but are not limited to:
- 2946 • Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and
2947 federal governments to ensure their functions as wildlife reserves in perpetuity.
 - 2948 • Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting
2949 habitat in a series of Marbled Murrelet Conservation Areas (MMCA's).
 - 2950 • Conduct a combination of night and daytime surveys and stand searches to locate both known,
2951 and any new, owl activity centers.
 - 2952 • Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other
2953 conservation elements of the HCP for the retention and recruitment of potential foraging,
2954 roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
 - 2955 • Maintain a minimum of 108 activity centers each year over the life of the HCP.
 - 2956 • Maintain an average reproductive rate of at least 0.61 fledged young per pair, over a five-year
2957 period, for the minimum of 108 activity centers on the ownership.
 - 2958 • Conduct complete annual censuses to monitor all activity centers on the ownership and to
2959 determine numbers of pairs, nesting pairs, and reproductive rates.
 - 2960 • Survey the THP area and a 1,000-foot buffer for new operations, except site preparation,
2961 initiated in the period beginning February 21 and ending on or before August 31.
 - 2962 • Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and
2963 detection probabilities using accumulated survey data.
 - 2964 • Submit annual reports describing the activities undertaken, results of the Operating
2965 Conservation Program, and the proposed Operating Conservation Program activities for the next
2966 year for all lands covered by the HCP.
 - 2967

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2968 Annual reports for Northern Spotted Owl have been developed since the HCP's inception. The most
2969 current report (HRC 2015) summarizes the Humboldt Redwood Company's survey effort and whether
2970 management objectives were met. The report states,

2971 "Management objective 1 of the HCP, which requires the maintenance of a minimum of 108
2972 activity sites in the HCP area, was met in 2014 with 136 total occupied activity sites including the
2973 108 core sites. There are currently 215 total activity sites (occupied and unoccupied) on the
2974 property. Management objective 2, which calls for maintenance of Spotted Owl pairs on a five
2975 year running average of 80% at core activity sites, was met in 2014 with a running average of
2976 82%. The pair occupancy rate for 2013 was also 84% (91 of the 108 cores sites were occupied by
2977 a pair of Spotted Owls). Management objective 3 requires the maintenance of a five-year
2978 running average reproductive rate of at least 0.61 fledged young per pair for the core sites (for
2979 those pairs monitored to determine reproductive output). Nesting activity was verified for 33 of
2980 the 91 pairs (of the 108 core sites), and a total of 45 young were fledged, resulting in a
2981 reproductive rate of 0.49 in 2014. The five-year running average of the reproductive rate for the
2982 fifteenth year of the HCP is 0.42, below the requirements of management objective 3."

2983 *Mendocino Redwood Company HCP/NCCP (in planning process; not issued)*

2984 The Mendocino Redwood Company (MRC) is in the process of developing a HCP and NCCP with the
2985 federal and state agencies. Once the permit is issued, the term will be 80 years. The HCP/NCCP will
2986 determine how MRC manages threatened and endangered species, rare plants, and natural
2987 communities on their land ownership in Mendocino and Sonoma counties. The Northern Spotted Owl
2988 will be a covered species in the plan. Approximately 228,800 acres of coast redwood and Douglas-fir
2989 forests exist on MRC land ownership and is located within the California Coast Province. Up to date
2990 progress on the HCP/NCCP development can be found on the MRC website (<http://www.mrc.com>).

2991 *Terra Springs LLC HCP*

2992
2993 The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the
2994 Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa
2995 County west of the city of St. Helena, and is located within the California Coast Province. The plan has a
2996 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year
2997 old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered
2998 lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the
2999 covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded
3000 by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to
3001 maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while
3002 accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting,
3003 roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their
3004 management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees,
3005 felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices,
3006 retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous

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snags, retention of down logs; (3) Timber operations to cease within a 1000 ft buffer of the owl activity center during the breeding season; (4) Monitor the Spotted Owl site for five years subsequent to the timberland conversion; and (5) Annual reporting for the first 5 years of the permit.

Fruit Growers Supply Company HCP

The Fruit Growers Supply Company (FGS) HCP covers commercial timberland owned and managed by FGS in Siskiyou County, totaling 152,178 acres (FGS 2012). The Plan Area is within the California Klamath Province and California Cascades Province. The HCP has a 50 year term that expires November 27, 2062. In February 2014, FGS notified the Department that the federal BO was issued and requested that the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1. In March 2014, after an amendment to the HCP to fully meet mitigation standards, the Department found that BO and its related ITS and ITP, and the HCP were consistent with CESA and meet the conditions set forth in Fish and Game Code section 2081 for authorizing incidental take of CESA-listed species (CDFW 2014c).

In April 2015, the United States District Court, Northern District of California, found FGS's HCP to be invalid for the incidental take of two threatened species, the Northern Spotted Owl and the Southern Oregon/Northern California Coast Coho Salmon. The Order on Cross-Motions for Summary Judgment in the case *Klamath-Siskiyou Wildlands Center, Center for Biological Diversity, and Klamath Forest Alliance vs. National Oceanic and Atmospheric Administration, National Marine Fisheries, and the United States Fish and Wildlife Service, and Fruit Growers Supply Company* states, "For the reasons explained below, the Court ... finds the incidental take permits issued by the Services, the biological opinion issued by NMFS, and the Final Environmental Impact Statement invalid." The HCP amendment to fully meet mitigation standards was not considered in this case.

Timber management was the primary activity affecting approximately 150,000 acres. FGS land consists of three management units: Klamath River covering 65,340 acres, Scott Valley covering 39,153 acres, and Grass Lake covering 47,685 acres. Klamath River and Scott Valley units are dominated by second-growth mixed evergreen forests that include Douglas-fir, incense-cedar, white fir, ponderosa pine, sugar pine, canyon live oak, Pacific madrone, California black oak, and Oregon white oak. The Grass Lake unit contains three major forest types: Sierran Montane Forest and Upper Montane Forest at higher elevations and Northern Yellow Pine Forest at lower elevations. The Northern Yellow Pine is most common in the Grass Lake unit, and is dominated by ponderosa pine and white fir. The hardwood understory species (e.g., oak species and madrone) are largely absent in this unit. Because most of FGS land has been in commercial timber production since the early 1900s, forests are relatively young (less than 80 years old) with only small, isolated patches of older stands. Less than 1 percent of the forested area in the three management units are in WHR size class 5 (> 24 inches dbh) and are considered late-seral stage. Most of the forested lands (79-93%) are in WHR size classes 3 and 4 (6-24 inches dbh) and are considered mid-seral.

Covered Activities had the potential to alter forest characteristics, and influence the availability and quality of habitat for Northern Spotted Owls. Northern Spotted Owl surveys on FGS lands and adjoining

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3046 federal and private lands have shown that many activity centers are located on or have a home range
3047 that extends onto the FGS ownership.

3048 Safe Harbor Agreements

3049
3050 The USFWS states (<http://www.fws.gov/endangered/landowners/safe-harbor-agreements.html>):

3051 “A Safe Harbor Agreement (SHA) is a voluntary agreement involving private or other non-
3052 Federal property owners whose actions contribute to the recovery of species listed as
3053 threatened or endangered under the ESA [see section 10(a)(1)(A)]... In exchange for actions that
3054 contribute to the recovery of listed species on non- Federal lands, participating property owners
3055 receive formal assurances from the Service that if they fulfill the conditions of the SHA, the
3056 Service will not require any additional or different management activities by the participants
3057 without their consent. In addition, at the end of the agreement period, participants may return
3058 the enrolled property to the baseline conditions that existed at the beginning of the SHA.”

3059 There are two SHAs covering Northern Spotted Owl in California, Forster-Gill, Inc., and The Fred M. van
3060 Eck Forest Foundation.

3061
3062 *Forster-Gill, Inc., Safe Harbor Agreement*
3063

3064 The Forster-Gill SHA was issued in June 2002 has a 90-year term, and consists of 236 acres in Humboldt
3065 County one mile north of the town of Blue Lake (USFWS 2002). The majority of the property (91%)
3066 contains young growth coastal redwood (30-35 years old), with 216 acres containing WHR type 4D (12-
3067 24 inch dbh and 60-100 percent canopy closure). At the time of the SHA issuance two owl activity
3068 centers were adjacent to the property, both associated with one pair.

3069 In the SHA, Forster-Gill agrees to enhance and maintain approximately 216 acres of forested Northern
3070 Spotted Owl habitat through timber harvest management designed to create uneven-aged stands with
3071 large tree components, characteristic of high quality owl habitat. Specifically, the SHA will:

- 3072
- 3073 • Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
 - 3074 • Retain all snags not posing a hazard risk.
 - 3075 • Conduct annual owl surveys on property and within a 500 foot radius around the property.
 - 3076 • Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
 - 3077 • Ensure no harvest occurs within 1,000 ft of any active owls nest site.
 - 3078 • Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single
3079 tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and
3080 approved by USFWS.
 - 3081 • Conduct timber stand inventories and provide USFWS with data.
 - 3082 • Allow USFWS or other agreed-upon party access to property for monitoring and management
3083 activities.

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The Fred M. van Eck Forest Foundation Safe Harbor Agreement

The van Eck Foundation SHA was issued in August 2008 has a 90-year term, and covers management activities on 2,163 acres of land in Humboldt County owned by The Fred M. van Eck Forest Foundation (USFWS 2008a). Four management units are identified, of which three (Lindsay Creek, Squaw Creek and Fieldbrook) are located in the Lindsay Creek watershed about one mile of the town of Fieldbrook. The fourth unit, Moonstone, is located in the about ½ mile east of the community of Westhaven. The main forest types found include redwood, Douglas-fir, grand fir, western hemlock, and Sitka spruce. Approximately 80% of the land contains nesting and roosting habitat, with dense canopy cover, and trees over 16 inch dbh. At the time of SHA issuance, no Spotted Owl nesting was documented, however roosting single and pairs were.

The SHA incorporates the terms of the conservation easement granted to Pacific Forest Trust (PFT) in 2001. The conservation easement includes performance goals and restrictions that create forest component recognized as high quality owl habitat.

In the SHA, van Eck Foundation agrees to maintain and protect 6.5 acres of nesting and roosting habitat surrounding an AC, and limit harvesting to single-tree selection or group selection with a target of retaining native species and trees that grow vigorously. Exceptions will be made for trees that have been identified for snag or wildlife tree retention. Canopy cover will remain above 80% (averaged across the stand) upon completion of harvesting activities. Specifically, the SHA will:

- Comply with the conservation strategy, including management performance goals, restrictions on harvest, and road construction and maintenance conditions.
- Retention of all snags not posing a safety hazard.
- Conduct protocol-level surveys and determine reproductive status on property and within 500 foot radius off property, with annual surveys at Lindsay Creek, Squaw Creek, and Fieldbrook units, and one year prior to harvesting activities at Moonstone unit.
- Implement protection measures for up to five activity centers.
- Conduct following protection measures: maintain a 300 foot no-harvest-buffer on up to two activity centers, maintain a 100 foot limited-harvest-buffer on up to three activity centers, no harvest operations to occur within 1,000 feet of any activity center during the breeding season, and no harvest of any known owl nest trees.
- Cooperate with USFWS on Barred Owl control measures.
- Submit timber inventory reports according to management units
- Allow the USFWS or other agreed-upon party, access to property.
- Conduct annual protocol-level surveys and determine reproductive status and success at owl nest sites found for a minimum of three years post-harvest.

Exemption Harvest

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3122 Exemption harvest is meant to assist private landowners wanting/needing to remove trees and may
3123 allow the removal to be exempt from the THP process. The different types of exemptions available
3124 include:

- 3125 • Forest Fire Prevention Exemption
- 3126 • Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption
- 3127 • Less Than Three Acre Conversion Exemption
- 3128 • Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption
- 3129 • Public Agency, Public and Private Utility Right of Way Exemption
- 3130 • Woody Debris and Slash Removal Exemption
- 3131 • Removal of Fire Hazard Tree within 150 feet of a Structure Exemption
- 3132 • Drought Mortality Amendment Exemption 2015
- 3133 • Protection of Habitable Structures Exemption 2015

3134
3135 Any of the above mentioned exemptions may impact Northern Spotted Owls either directly through
3136 habitat removal or indirectly through noise or visual disturbance, depending on the location and on the
3137 yearly timing of operations

3138 Exemption harvest operations must comply with all aspects of the Forest Practice Rules and various
3139 restrictions regarding the operations under the various emergency conditions. In exemption harvest
3140 actions, no known sites of rare, threatened or endangered plants or animals are to be disturbed,
3141 threatened or damaged. However, Northern Spotted Owl protocol-level surveys and habitat
3142 assessments are not generally required by the Forest Practice Rules to operate under an exemption.

3143 Not all exemptions require an RPF certification. Those that do not require the certification are:
3144 Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption, the Public Agency,
3145 Public and Private Utility Right of Way Exemption, Drought Mortality Amendment Exemption and the
3146 Removal of Fire Hazard Trees within 150 feet of a Structure Exemption.

3147 The Christmas Tree/Dead, Dying or Diseased Fuel wood or Split Products Exemption has been available
3148 during the entire time period in which the Northern Spotted Owl has been listed as threatened by the
3149 USFWS. Tree removal is limited to less than 10 percent of the average volume per acre and can be
3150 applied to an entire ownership on any size.

3151 The Forest Fire Prevention Exemption allows the harvest of green merchantable trees, but the logging
3152 area is limited to 300 acres in size and a statement of the postharvest stand stocking level is required as
3153 required in 1038(i) in the Forest Practice Rules.

3154 The Less Than Three Acre Conversion Exemption is applicable to a conversion of timberland to a non-
3155 timber use only, of less than 3 acres in one contiguous ownership, whether or not it is a portion of a
3156 larger land parcel and shall be not part of a THP. Within one month of the completion of timber
3157 operations, including slash disposal, the timberland owner shall submit a work completion report to CAL
3158 FIRE.

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3159 The Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption is not limited to 10% of
3160 the volume per acre and the landowner must notify CAL FIRE of the completion of timber operations
3161 within 30 days of their cessation.

3162 The Public Agency, Public and Private Utility Right of Way Exemption , working with Public Resources
3163 Code section 4628 and Forest Practice Rules section 1104.1(b) exempts public agencies from the
3164 requirement to file an application for timberland conversion or a THP when they construct or maintain
3165 rights of way on their own property or that of another public agency. This exemption extends to
3166 easements over lands owned in fee by private parties. This exemption is not available for rights of way
3167 granted from one private landowner to another.

3168 The Woody Debris and Slash Removal Exemption allows the removal of woody debris and slash that is:
3169 (1) located outside the WLPZ, (2) within the reach of loading equipment operating on existing roads and
3170 landings, (3) developed during timber operations, (4) delivered as combustion fuel for the production on
3171 energy, and (5) in compliance with the conditions of Forest Practice Rules section 1038 subdivision (b)
3172 paragraphs (3),(4),(6),(7),(8) and (10).

3173 The Removal of Fire Hazard Trees within 150 feet of a Structure Exemption allows only trees within 150
3174 feet of an approved and legally permitted structure that complies with the California Building Code
3175 (includes only structures designed for human occupancy, garages, barns, stables and structures used to
3176 enclose fuel tanks) may be harvested under this Notice of Exemption.

3177 The Drought Mortality Exemption was adopted in 2015 by the Board of Forestry due to the prolonged
3178 drought and supercedes the provisions of any other exemption in the same harvest footprint (harvesting
3179 of dead and dying trees). Trees that are dead or trees with fifty percent or more of foliage-bearing
3180 crown that is dead or fading in color are eligible for removal. Under this exemption, it is required to
3181 retain an average for the harvest area of not less than one decadent and deformed tree of value to
3182 wildlife, snag or dying tree per acre that is greater than sixteen inches diameter breast height and
3183 twenty feet tall. This provision does not apply within 100 feet of habitable structures, roads, fire
3184 suppression ridges and infrastructure facilities such as transmission lines and towers or water
3185 conveyance and storage facilities. This exemption requires an RPF signature when timber operations on
3186 a cumulative harvest area exceed twenty acres per total ownership.

3187 The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to
3188 the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet
3189 from any point of an habitable structure that complies with California Building Code for the purpose of
3190 reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily
3191 comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the
3192 treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2,
3193 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project
3194 area shall be increased in the post-harvest stand.

3195 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3196 approximately 41,767,250 acres (1992 to 2013) have been exempted for harvest in counties within the

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range of Northern Spotted Owl (CAL FIRE 2014). These acres do not represent operational acres (actual acres harvested) but only notification acres (possible intended acres harvested). Operational acre reporting is not required; therefore there is no data representing the precise amounts or locations of areas harvested under an exemption. Some of these acres are most likely outside the known range of the Northern Spotted Owl. In addition, some landowners prepare notifications for their entire ownership yearly; yet may only operate on only a small area, thereby possibly compounding this acreage total.

Volume of timber removed under an exemption is reported to the Board of Equalization (BOE), and is another way to assess levels of exemption harvest. With the precise location and yearly timing of the volume reported unknown, specific impact assessments cannot be developed. However, the total volume harvested, average volume amounts by each county and total percentage of harvest volume may be enough to determine that more information is needed. Yearly exemption harvest volume from the counties within the known Northern Spotted Owl range date back to 1990 and average approximately 49,456 MBF (1,000 board-foot) and represent approximately 4.87% of total volume harvested. The highest total amount harvested occurred in 1994 totaling 164,232 MBF, accounting for 15% of the total volume harvested that year. The total exemption volume harvested during the time that Northern Spotted Owl has been listed as threatened by the USFWS is 1,186,954 MBF. The largest amount of exemption volume recorded is from Shasta in 1994 totaling 79,993 MBF, with the largest percentage of total volume coming from Napa (1994), Marin (1996), Glenn (2003), and Lake (2005), where 100% of the total volume harvested was exemption volume (BOE 2014). These volume amounts do not include all volume as the BOE reporting requirements only require volume reporting when \$3000.00 is obtained. The BOE does not track the volume that is less than \$3000.00 in value (A. Tenneson, personal communication, November 18, 2015).

It is not known if the long-term exemption harvesting on private lands in California is limiting Northern Spotted Owl populations, but exemption harvesting may reduce well defined/ critical habitat elements over time. The current exemption harvest process does not require owl habitat analysis or surveys and may directly impact Northern Spotted Owl, and therefore more information is needed to fully assess the impacts from exemption harvest.

Emergency Harvest

Private landowners may cut or remove timber under an emergency basis if “emergency conditions” exist pursuant to Forest Practice Rules section 895.1. Emergency conditions are defined as, “... those conditions that will cause waste or loss of timber resources to the timber owner that may be minimized by immediate harvesting of infected, infested or damaged timber or salvaging down timber; or those conditions that will cause appreciable financial loss to the timber owner that may be minimized by immediate harvesting of timber.”

Types of emergency conditions include:

- Dead or dying trees as a result of insects, disease, parasites, or animal damage.

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3235 • Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood,
3236 landslide, or earthquake.
3237 • Dead or dying trees as a result of air or water pollution.
3238 • Cutting or removing trees required for emergency construction or repair of roads.
3239 • Cutting and removal of hazardous fuels.
3240 • Treatments to eradicate an infestation of Sudden Oak Death.
3241
3242 There is some overlap with types of emergency conditions between Exemption and Emergency harvests.
3243 Exemption Harvest allows only 10% of volume of “dead and dying trees” to be removed, while under an
3244 Emergency Harvest the minimum stocking standards need to be met and does not allow the harvest of
3245 merchantable sawlogs. In addition, Emergency Harvests allow removal of dead trees or trees instituting
3246 an obvious large scale economic loss, whereas Exemption Harvest does not.

3247 Emergency Harvest operations must comply with all aspects of the Forest Practice Rules specific to
3248 emergency operations (Forest Practice Rules § 1052 subd. (a)). Before cutting or removing timber on an
3249 emergency basis, an RPF on behalf of a timber owner or operator must submit a Notice of Emergency
3250 Timber Operations. In Emergency Harvest, no known sites of rare, threatened or endangered plants or
3251 animals are to be disturbed, threatened or damaged. However, Northern Spotted Owl protocol-level
3252 surveys and habitat assessments are not generally required to operate during emergency conditions.

3253 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3254 between 1992 and 2013 approximately 344,542 acres (CAL FIRE 2014) have been notified for emergency
3255 harvest in counties within the owl’s range. These acres may not represent operational acres (actual
3256 acres harvested) but only notification acres (intended acres harvested). Depending on the emergency
3257 condition and stocking requirement, operational acre reporting may not be required; therefore there is
3258 no acreage data or mapping data representing the precise amounts or locations for all emergency
3259 operational areas.

3260 Emergency harvest operations mostly occur in areas where forest stand conditions are dead or fallen,
3261 forest habitat conditions not meeting the definitions of suitable habitat for Northern Spotted Owl under
3262 the Forest Practice Rules, however indirect impacts may occur as a result of the emergency operation.
3263 The emergency notification data is compiled yearly by county, therefore Northern Spotted Owl range-
3264 specific data is not available. Of the total notification acres between 1992 and 2013, some are most
3265 likely outside the known range of the Northern Spotted Owl as the known range line does not include all
3266 of the county area within this acreage data set.

3267 It is not known if the long-term emergency harvesting on private lands in California is limiting Northern
3268 Spotted Owl populations, however, there is some evidence that salvage logging effects use of burned
3269 areas by Spotted Owls. See the discussion of wildfire in the Threats section for additional discussion on
3270 this type of emergency harvest. Some indirect impacts, such as noise disturbance, may be occurring as a
3271 result of emergency operations but level and extent of this potential impact is not well documented.
3272 More information is needed to fully assess the impacts to Northern Spotted Owl from emergency
3273 harvesting.

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Other Management Actions

Forest Certification Programs

Some private landowners in California have voluntarily worked with organizations to achieve certification for their forest landholdings and forestry practices. There are numerous organizations that certify forest products, with Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) being two of the largest. In order for a landowner to attain certification, they must achieve certain conservation requirements and initiate specific management activities to meet these requirements. For example, a landowner may be required to increase retention in even-aged units, and to achieve this 10-30% of the pre-harvest basal area might be retained in a clumped or dispersed fashion. Another example that could benefit Northern Spotted Owl would be protection of old-growth and legacy trees through the creation of policy and planning documents that ensure their identification and protection (T. Bolton, personal communication, September 5, 2014).

The FSC conducts audits to ensure compliance with FSC certification. In addition, the FSC certification has geographic-specific indicators for the US and Pacific Coast region (FSC 2010a, S. Chinnici, personal communication, September 3, 2014) and has developed a draft framework for assessing “High Conservation Value Forests” (HCVFs) to help land managers identify lands with high conservation value (FSC 2010b). Lands determined to be of high conservation value have extra requirements for monitoring. Conserving these lands enables landowners to get credit for conservation while being able to manage other parts of their land for timber products (FSC 2010a).

The Department does not have an accounting of the number of acres of timberland covered by a forest certification program, nor the quality of the management activities required to meet certification. Therefore, there is not enough information available to suggest what kind of impact, if any, forest certification has had on Northern Spotted Owl populations. However, certification programs may have a positive effect on Northern Spotted Owl in cases where more foraging, nesting, or roosting habitat is maintained than that called for in the Forest Practice Rules.

Conservation Easements

Most of the conservation easements in forested environments within the Northern Spotted Owl range allow for some sort of timber harvest. The Department is involved in only a portion of easement/title projects, and of these projects, the Department is typically not a landowner, title-holder, or manager of these lands. While working with landowners and managers on the easement/title conditions, the Department Lands Program staff suggests conditions conducive to the protection and conservation of wildlife and their habitats.

Due to the variability of landowner needs, the conditions agreed upon for easements constitute a wide range of habitat protection. Thus, it is difficult to draw conclusions as to how easements/titles are contributing to Northern Spotted Owl conservation. Additionally, these areas are not rigorously studied specific to the Northern Spotted Owl.

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State Forests

CAL FIRE operates eight Demonstration State Forests in California, totaling about 71,000 acres. A majority of these forests are actively managed as timberlands and annually produce on average about 30 million board feet of wood. About 53,145 actively-managed acres of State Forest lands occur within the range of the Northern Spotted Owl; this includes Ellen Pickett State Forest (158 acres), Las Posadas State Forest (843 acres), Boggs Mountain Demonstration State Forest (3,425 acres), and Jackson Demonstration State Forest (48,719 acres). State Forests are intended to be used for experimentation and demonstration of various silvicultural methods for their economic and environmental/scientific value. The State Forests have management plans that are periodically reviewed by BOF and all timber harvesting activities on State Forests must comply with the Forest Practice Act and the Forest Practice Rules, including the measures to avoid take of Northern Spotted Owl found in Forest Practice Rules sections 919.9 and 919.10.

Jackson Demonstration State Forest (JDSF) is the largest of the eight forests (49,000 acres) and represents nearly 70% of the total State Forest acreage in California. This forest has been managed and harvested since 1862 and was acquired by the State in 1947. Located in central Mendocino County, the forest consists primarily of coast redwood and Douglas-fir, with some old-growth coast redwood remaining. Forest stands on JDSF have been managed on an even-aged and uneven-aged basis under various silvicultural systems; however, special restrictions are put on even-aged management and clear-cutting (CDF 2008, CDF 2014).

The JDSF Management Plan (CDF 2008) contains a Northern Spotted Owl Conservation Strategy, with the goal to “maintain or increase the number and productivity of nesting owl pairs through forest management practices that enhance nesting and roosting opportunities and availability of a suitable prey base.” CAL FIRE monitors certain Northern Spotted Owl activity centers on JDSF and the Management Plan conditions are nearly identical to the Forest Practice Rules.

State Parks

The California Department of Parks and Recreation (CA State Parks) manages 280 park units in California; 64 of these park units are within the range of the Northern Spotted Owl, totaling 214,286 acres. CA State Parks’ mission, in addition to preserving biodiversity, includes protecting cultural resources and creating recreation opportunities. CA State Parks does not have a management plan for the Northern Spotted Owl and management for species occurs at the park unit scale. Each park unit prepares a general plan that describes the range of activities occurring within the park unit and resource protection that the park unit enables.

The largest State Park (SP) in the Northern Spotted Owl range, Redwood National and State Parks, is jointly managed by the NPS and CA State Parks and includes: Redwood National Park, Jedediah Smith Redwoods SP, Del Norte Coast Redwoods SP, and Prairie Creek Redwoods SP. RNSP does not have specific Northern Spotted Owl management actions in its General Management Plan/General Plan, but does have vegetation management actions for old-growth, second-growth, prairie and fires. Old-growth forests are protected, managed, and restored to provide habitat for species and to reduce fire hazards.

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3353 Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to
3354 reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak
3355 woodlands and prairies is managed through tree removal and burning. Nine management zones within
3356 the RNSP delineate the degree of human influence and development on that can occur on the landscape
3357 (NPS 2000a).

3358 Similar to Redwood National and State Parks, the second largest park unit within the Northern Spotted
3359 Owl range, Humboldt Redwoods State Park, does not engage in specific management activities for
3360 Northern Spotted Owl, but protects and manages for old-growth stands to be sustained over time (CDPR
3361 2001).

3362 California State Parks do not engage in regular surveys for Northern Spotted Owl within State Parks,
3363 though surveys sometimes occur before park projects are started. However, adjacent timberland
3364 owners routinely survey Northern Spotted Owl activity centers within State Parks (T. Fuller, personal
3365 communications, September 2, 2014).

3366 *University of California Natural Reserves*

3367
3368 Comprised of more than 756,000 acres across 39 sites and representing most major California
3369 ecosystems, the UC Natural Reserve System (UCNRS) is the largest university-administered reserve
3370 system in the world. By supporting university-level teaching, research, and public service, the UCNRS
3371 contributes to the understanding of and wise stewardship of California's natural resources. Five UCNRS
3372 sites (totaling 4,625 acres) across California occur within the range of the Northern Spotted Owl, though
3373 there are no management plans or Northern Spotted Owl SO data for individual reserves (UC 2014).
3374 Angelo Coast Range Reserve has had three Northern Spotted Owl territories through since the late-
3375 1980s, but since Barred Owls were detected in the area starting in 1999 Spotted Owls have not been
3376 detected at any of the three sites (A. Franklin, personal communication, March 23, 2015).

3377 *Department Ecological Reserves*

3378
3379 Authorized by the California Legislature in 1968 and administered by the Department, the ecological
3380 reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats,
3381 and to provide areas for education and scientific research. The system now encompasses 119 properties
3382 totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur
3383 within the range of the Northern Spotted Owl; however there are no management plans for the system
3384 or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception
3385 is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by
3386 BLM, which manages for late seral habitat benefiting Spotted Owls.

3387 *Fisheries Restoration Grant Program*

3388 As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern
3389 Spotted Owls and their habitat are required for each project funded. The purpose of FGRP is to support
3390 restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must

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3391 provide a detailed proposal that thoroughly addresses all criteria of the FGRP, one of which is avoidance
3392 and minimization measures for Northern Spotted Owls if a project proposes to conduct work in owl
3393 habitat. The geographic area covered by FGRP almost completely overlaps with the Northern Spotted
3394 Owl range in California, therefore the potential for a project be in owl habitat is high. Once a project is
3395 approved, the proponent must obtain a Lake or Streambed Alteration Agreement (LSAA) from the
3396 Department to comply with the CEQA. The LSAA will include conditions for the protection of wildlife and
3397 habitat, and must be followed during project activities.

3398 To avoid potential impacts to Northern Spotted Owls FRGP projects must adhere to the following, as
3399 noted in the LSAA:

- 3400 • Work with heavy equipment at any site within 0.25 miles of suitable habitat for the Northern
3401 Spotted Owl shall not occur from November 1 to July 9.
- 3402 • The work window at individual work sites may be advanced prior to July 31, if protocol surveys
3403 determine that suitable habitat is unoccupied.
- 3404 • If these mitigation measures cannot be implemented or the project actions proposed at a
3405 specific work site cannot be modified to prevent or avoid potential impacts to Northern Spotted
3406 Owls or their habitat, then activity at that work site will be discontinued and the project
3407 proponent must obtain incidental take authorization from the USFWS.
- 3408 • For projects contained within streams and watersheds included in a USFWS Habitat
3409 Conservation Plan the mitigation measures contained within those Habitat Conservation Plans
3410 shall be followed.

3411 The grant program is very successful and funds numerous projects each year. In fiscal year 2013/2014
3412 alone, FRGP funded approximately \$16.5 million dollars in 56 projects, of which 44 projects were located
3413 within the range of the Northern Spotted Owl.

3414 **Threats (Factors Affecting Ability to Survive and Reproduce)**

3415

3416 **Historical Habitat Loss and Degradation**

3417 *Historical Habitat Loss*

3418 Historical (pre-logging) variability in forest age and structure in the range of the Northern Spotted Owl
3419 was controlled by natural processes, including wildfires (Courtney et al. 2004). Estimates of pre-logging
3420 extent of old forest in western Washington and Oregon are relatively consistent and range from 60 to
3421 72% of the landscape (Courtney et al. 2004). When the USFWS listed the Northern Spotted Owl as
3422 threatened in 1990, estimates of historical Spotted Owl habitat loss ranged from 60 to 88% loss
3423 rangewide since the early 1800s (USFWS 2011a). Much of this loss was attributed to timber harvest and
3424 to land-conversion, and was concentrated mostly at lower elevations and in the Coast Ranges (USFWS
3425 2011a). This pattern of historical loss is apparent in the current distribution of suitable habitat, with

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3426 large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat
3427 (see Figure 4).

3428 Prior to 1990, the annual rate of removal of Spotted Owl habitat on national forests as a result of logging
3429 had been about 1% per year in California and 1.5% per year in Oregon and Washington (USFWS 1990,
3430 2011). At the time, it was projected that future rates of habitat removal would eliminate all nesting and
3431 roosting habitat on non-protected BLM lands in Oregon, with the exception of the Medford District, by
3432 the year 2016 (USFWS 1990). Estimates from the decades before 1990 indicate that harvest rates on
3433 private industrial lands were consistently about twice the average rate of harvest on public land (Cohen
3434 et al. 2002). Regarding harvest rates on private industrial and non-industrial lands, Bigley and Franklin
3435 (2004) estimated harvest rates in the late 1980s and early 1990s for private industrial land of 2.4% per
3436 year, and harvest rates on non-industrial lands increased from 0.2% in the 1970s to a rate similar to that
3437 of the private industrial lands by the early 1990s.

3438 *Assessing Habitat Loss through Implementation of the Northwest Forest Plan*

3439 The Northern Spotted Owl was listed under the federal Endangered Species Act in 1990 in part because
3440 of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised
3441 recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls,
3442 ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or degradation from stand
3443 replacing wildfire and other disturbances, and loss of amount and distribution of Spotted Owl habitat as
3444 a result of past activities and disturbances (USFWS 2011a). To address ongoing decline of Northern
3445 Spotted Owl habitat across the range, the NWFP established reserved lands including late-seral reserves,
3446 adaptive management reserves, congressionally reserved lands, managed late-successional areas, and
3447 larger blocks of administratively withdrawn lands (USDA and USDI 1994) (Figure 11). These are described
3448 in more detail above. It was assumed that habitat in reserves would improve over time as successional
3449 processes led to more mature forests, however, this is a slow process and so recruitment of habitat
3450 conditions on reserves was expected to take many decades (citation?). It was also assumed that habitat
3451 outside of reserves would continue to decline due to timber harvest and other disturbances but that
3452 dispersal habitat would be maintained in order to facilitate movement between reserve lands (citation).
3453 Given the continued Northern Spotted Owl population declines and the increasing threat of the Barred
3454 Owl, the revised recovery plan recommended conserving occupied sites and unoccupied, high-value
3455 Spotted Owl habitat on state and private lands wherever possible (USFWS 2011a).

3456 In order to understand the degree to which the NWFP contributes to conservation of owl habitat, the
3457 rangewide trends in habitat are regularly assessed. To date, assessments have been performed at the
3458 10-year and 15-year time points (Davis and Lint 2005, Davis et al. 2011). The recent assessment
3459 estimated rangewide habitat changes on federal and nonfederal lands from 1994 through 2007 for
3460 California and from 1996 through 2006 in Oregon and Washington by comparing vegetation maps for
3461 two bookend time periods. In addition to rangewide changes, trends for each physiographic province
3462 and for each state are also reported (Davis et al. 2011). The assessment tracks changes in Northern
3463 Spotted Owl nesting and roosting habitat, and also tracks changes in dispersal habitat within and

Comment [DK62]: Davis et al. 2015 is now available too I think – a draft at least is available here:
<http://www.reo.gov/monitoring/reports/20yr-report/>

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3464 between the reserves. Foraging habitat is not assessed through modeling for the NWFP. Nesting and
3465 roosting habitat maps were produced through habitat suitability modeling using several forest structure
3466 variables (e.g., percent conifer cover, average conifer dbh, average stand height) and a forest age
3467 variable (Davis et al. 2011). Vegetation stands were placed in one of four categories (highly suitable,
3468 suitable, marginal, and unsuitable), with highly suitable and suitable categories assumed to represent
3469 nesting and roosting habitat (Davis et al. 2011). To assess change, an area was considered to have lost
3470 nesting and roosting habitat if its condition moved from suitable or highly suitable to marginal or
3471 unsuitable.

Comment [DK63]: Update all of this based on Davis et al. 2015

3472 Although federal lands contain less than half of the total forest land within the entire range of the
3473 Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and
3474 roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and
3475 roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands
3476 lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal
3477 lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance
3478 (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost
3479 on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the
3480 fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl
3481 range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands
3482 has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only
3483 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on
3484 nonreserved lands.

Comment [DK64]: Also new old growth forest report – Spies and Davis I think. Draft should be on the web site listed above.

3485 Conversely, on nonfederal lands most of the nesting and roosting habitat loss was due to harvest (about
3486 625,600 acres; 14.9%). On nonfederal lands in Oregon and Washington, the extent of older forest
3487 harvested annually declined following implementation of the NWFP. However, this decline was likely
3488 due to exhaustion of the available inventory, as the annual harvest rate stayed relatively steady when
3489 measured as a percentage of the remaining older forest (Healey et al. 2008). A relatively small amount
3490 of nesting and roosting habitat on nonfederal lands was lost to fire, insects, and disease (0.6%; about
3491 23,700 acres).

3492 Relative rates of nesting and roosting habitat loss on federal vs. nonfederal lands in California follow the
3493 rangewide pattern. Consistent with the entire subspecies range, loss of nesting and roosting habitat on
3494 federal lands in California was mostly due to wildfire and other natural disturbances (4.2%; 77,500
3495 acres), with a higher rate of loss than on federal lands rangewide (2.8%) (Davis et al. 2011). Most of the
3496 loss to natural disturbance in California occurred in the Klamath Province (73,200 acres), with almost all
3497 of the loss due to wildfire (Davis et al. 2011). Harvest rate of nesting and roosting habitat on federal
3498 lands in California was fairly low and matched that of federal lands rangewide (0.6%; 11,200 acres),
3499 although 3.0% of the nesting and roosting habitat on federal lands in the California Cascades Province
3500 was harvested (6,500 acres), which was the highest rate of harvest on federal lands across all provinces
3501 rangewide (Davis et al. 2011).

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3502 As with the rangewide pattern, nonfederal lands in California experienced much greater loss of nesting
3503 and roosting habitat to harvest than to natural disturbance. The acreage of nesting and roosting habitat
3504 harvested on non-federal lands in California was about 90,200 acres (5.8%), which exceeds the total
3505 amount of habitat loss on federal lands in California (Davis et al. 2011). This is consistent with the
3506 rangewide pattern showing that the bulk of total nesting and roosting habitat loss has been due to
3507 harvest on nonfederal lands; although the majority occurred in Washington and Oregon, more nesting
3508 and roosting habitat was lost to harvest on non-federal lands (about 625,600 acres) rangewide than
3509 total loss on federal lands from harvest and natural disturbance combined (about 298,600 acres total)
3510 (Davis et al. 2011). California has more nesting and roosting habitat on nonfederal lands than either
3511 Washington or Oregon but has lost relatively less due to harvest, with Washington and Oregon losing
3512 18.6% and 21.8%, respectively, compared to 5.8% in California (Davis et al. 2011). This is likely due to
3513 differences in habitat retention requirements in the regulations of each state. On nonfederal lands in
3514 California, nesting and roosting habitat loss to natural disturbance was relatively low at 0.4% (about
3515 7,500 acres) (Davis et al. 2011).

3516 Davis et al. (2011) estimated amount of dispersal habitat across the range of the Northern Spotted Owl
3517 at the start of the NWFP and at the end of the study period (2006 or 2007 depending on location) by
3518 querying GIS vegetation databases for forests with conifer dbh ≥ 11 inches and conifer cover $\geq 40\%$ (see
3519 Figure 5). This is similar to the definition of minimum dispersal habitat from Thomas et al. (1990).
3520 Modeled nesting and roosting habitat was also included in the mapped dispersal habitat because owls
3521 will disperse through forests meeting the requirements of nesting and roosting habitat. Trends in
3522 dispersal habitat over the study period were analyzed within and between federal reserved lands. The
3523 distribution of “dispersal-capable” habitat was also mapped by combining results of the mapped
3524 dispersal habitat with estimates of maximum dispersal distance from Forsman et al. (2002) (Figure 17).
3525 This estimate of dispersal-capable habitat on the landscape allowed for a measure of the ability of owls
3526 to disperse between habitat reserves, which is a goal of the NWFP and an important functional measure
3527 of habitat beyond a simple acreage estimate of total dispersal habitat.

3528 Increases in dispersal habitat, as defined by conifer forests exceeding 11 inches dbh and 40% canopy
3529 cover, occurred through forest succession and through partial disturbance of nesting and roosting
3530 habitat to smaller, more open forest. Recruitment of dispersal habitat exceeded loss rate for a net
3531 increase of 5.2% rangewide (Davis et al. 2011). However, given the distribution of habitat increases and
3532 losses, the dispersal-capable habitat on the landscape decreased by about 1% (Davis et al. 2011); on
3533 federal lands this loss was largely due to wildfire (Figure 18). Losses of dispersal-capable habitat
3534 occurred mostly around the periphery of federal forests; Davis et al. (2011) suspect this is due to timber
3535 harvesting on nonfederal lands that border federal lands. Gains in dispersal-capable habitat also often
3536 occurred at the periphery of federal forests, as forest succession in younger or recently harvested
3537 forests led to forests meeting the minimum dispersal requirements.

3538 The network of large federal reserves across the range of the Northern Spotted Owl is fairly well
3539 connected, although there are exceptions in the Olympic Peninsula, the eastern Washington Cascades,
3540 and in the southern end of the range in California. The Marin County population is poorly connected to

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other federal reserves, and large portions of the California Coast physiographic province are mapped as having poor dispersal-capability. However, the definition of minimum dispersal habitat in Thomas et al. (1990) and used to map trends in the NWFP may not capture the full range of dispersal habitat conditions in Northern California, where Northern Spotted Owls use younger forests (USFWS 2011a).

Timber Harvest

Timber Harvest on Private Land

The Northern Spotted Owl was federally listed as Threatened in 1990 largely due to extensive habitat loss from timber harvest activities on federal and nonfederal land (USFWS 1990). In 1991, the California Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] were enacted, which describe options and procedures that can be used in THPs to avoid take of Northern Spotted Owl or to proceed under incidental take authorization. Compliance with the Forest Practice Rules apply to all commercial timber harvesting operations for private landowners (excluding specific exemptions discussed in the Timber Harvest Management section of this report) from small parcels operations to large timber operations. Forest Practice Rules 919.9[939.9] specify subsections (a) through (g), which give the landowner options among which to select and follow for timber harvest within the range of the Northern Spotted Owl.

THPs are plans submitted by the landowners that serve as the environmental review document, ~~and~~ ~~They outline~~ the ~~amount(?) and characteristics (stand composition, size, age, etc.) of~~ timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment, including impacts to Northern Spotted Owl activity centers. NTMPs are plans meant to promote the long term management and planning on forest ownerships of 2,500 acres or less, and they allow an alternate to submitting individual THPs prior to harvest. Landowners with approved NTMPs agree to manage their forests through uneven-aged management and long-term sustained yield.

As detailed in the Timber Harvest Management section of this report, the Department evaluated a subset of THPs and NTMPs submitted that fell within the range of the Northern Spotted Owl. Evaluation effort for each plan type varied depending on time constraints and level of information that was readily available, and included a summary of number of THPs submitted, types of silvicultural methods most used, and acres of habitat proposed for harvest and retention. For THPs, all plans submitted in 2013 were evaluated, and a subset of Northern Spotted Owl activity centers from plans utilizing Option (e) and (g) (the most commonly used options from Forest Practice Rules 919.9[939.9]) were followed back in time to summarize cumulative harvest activities impacting the owl sites. For NTMPs, plans submitted within interior counties from 1991-2014 were evaluated, and plans submitted within coastal counties from 2005-2014 were evaluated.

Within the interior THPs evaluated, the Alternative method was proposed more than any other method, covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total acreage. An Alternative silvicultural prescription can be included in a timber harvest plan when an alternative regeneration method or intermediate treatment is more effective or more feasible than any of the standard silvicultural methods (see Appendix 1). For plans using the Alternative method in the

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interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the Alternative method used. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more area than all other methods combined. Forest Practice Rules Section 913.4(d) defines Variable Retention as an approach to harvesting based on the retention of structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for integration into the post-harvest stand to achieve various ecological, social and geomorphic objectives (see Appendix 1).

Of the NTMPs evaluated, Selection, Group Selection, and Uneven-aged silvicultural methods are the most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection, Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Uneven-aged management means the management of a specific forest, with the goal of establishing a well-stocked stand of various age classes which permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop (see Appendix 1). Most NTMPs evaluated that used the Uneven-aged silvicultural method did not delineate acres that would fall under each category, therefore there is limited ability to assess the type of harvest applied on the landscape. Under the Selection and Group Selection methods, the trees are removed individually or in small groups sized within areas of 0.25 to 2.5 acres.

Types of silvicultural practices vary on the landscape and may impact Northern Spotted Owls differently depending on a variety of factors surrounding type and extent of habitat removed. For example Clear Cut harvesting (removal of an entire stand in one harvest), depending on how it is applied on the landscape, has [a-the](#) potential to negatively impact Northern Spotted Owls. Impacts from harvest have been recognized in the literature since the time the owl was federally listed (UFWS 2011a). Yet implementation of other frequently used silvicultural methods (e.g., Alternative, Variable Retention, Group Selection, Uneven-aged) have less obvious impacts to Northern Spotted Owl foraging, nesting, and roosting habitat. Some harvest methods may serve to reduce habitat quality by removing key components of owl habitat near Northern Spotted Owls activity centers. For example, thinning has been shown to decrease the abundance of Northern Flying Squirrels and Red Tree Voles, two important prey species for Northern Spotted Owls (Wilson and Forsman 2013). Alternatively, applied at appropriate scales, some methods may in fact serve to enhance owl habitat, for example, by increasing foraging opportunities [for certain prey types \(i.e., woodrats\)](#). Given the potential of both negative and positive impacts to the Northern Spotted Owl, more thorough documentation and rigorous evaluation of harvest type and actual harvest levels of foraging, nesting, and roosting habitat, within harvest plans are needed. In addition, research is needed to provide a clearer understanding of the effects of silvicultural practices on important prey species habitat.

To evaluate the level of impact of proposed harvest and retention to Northern Spotted Owl activity centers, each interior and coastal THP utilizing Option (e) and Option (g) in 2013 within the region was assessed further. Retention and harvest were assessed at two scales for interior THPs: within 0.5 miles and between 0.5 and 1.3 miles of an activity center. For coastal THPs, retention and harvest was only assessed within 0.7 miles of an activity center. For THPs utilizing Option (e), foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within

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0.5-1.3 miles). On the coast, foraging and nesting/roosting were retained at relatively similar levels within 0.7 miles (52,817 acres of foraging and 47,344 acres of nesting and roosting). For interior THPs utilizing Option (g) nesting/roosting (1,388 acres within 0.5 miles and 3,879 acres within 0.5-1.3 miles) and foraging habitat (1,032 acres within 0.5 miles and 3,171 acres within 0.5-1.3 miles) were similarly proposed for retention, and within the coast, more nesting/roosting habitat was retained (2,763 within 0.7 miles).

Timber harvest within the 0.5, 0.7 and 1.3 radii (representing different levels of habitat use by Northern Spotted Owls) has a potential to impact quality and extent of owl habitat, and consequently, owl fitness. Timber growth is slow, and consequently, regrowth of owl habitat is slow. Therefore, it is important to understand the cumulative impact to activity centers over time. As a way of evaluating this impact, the amount of habitat proposed for harvest was calculated for activity centers that were associated with THPs submitted in 2013 and utilized ing-Option (e) and Option (g) submitted in 2013 were selected, and harvest history followed back in time. Of the 17 activity centers evaluated in the interior, six activity centers have experienced greater than 2,000 acres timber harvest cumulatively over time within the 1.3 mile radius (~3,400 acres) home range, and six activity centers have experienced greater than 250 acres timber harvest within the 0.5 mile radius (~500 acres) core range. Of the 14 activity centers evaluated on the coast, six activity centers experienced harvest of over 500 acres, cumulatively, within the 0.7 mile radius (~985 acres) core range, with two of these over 1,000 acres (see Table 15, Table 16 and Appendix 3).

Of the interior NTMPs evaluated, 19 (54%) were associated with at least one Northern Spotted Owl activity center within 1.3 miles of the plan boundary. Of the coastal NTMPs evaluated, 96 (78%) were associated with at least one activity center within 1.3 miles of the plan boundary. For NTMPs, it was difficult to assess the extent of harvest and habitat retention because in some cases, the level of information available, particularly in older plans, was limited in some cases. Considering the NTMPs evaluated, we can infer that owl habitat is retained to some extent; however, we cannot determine the type or quality of habitat retained. For instance, high quality nesting and roosting habitat may be harvested more frequently, thereby reducing owl fitness.

Several research studies have demonstrated a link between owl fitness and amount of habitat, structural characteristics, and spatial configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007) – see the Habitat Effects on Survival and Reproduction and the Habitat Loss and Degradation sections of this document. Given what we know about owl habitat and fitness, it is reasonable to believe that high levels of harvest, such as levels documented for some activity centers in the harvest analysis described above, can negatively impact Northern Spotted Owls. In some of the activity centers evaluated for harvest history, harvest cumulatively exceeded the guidance provided in the Forest Practice Rules regarding the amount of habitat retention. Furthermore, by comparing territory loss on private timber lands to USFS lands from on private timber lands during 1978-2007, the USFWS (2009) found a 54% of territories surveyed were downgraded decline in occupancy status from a documented in pair, status to no response, and a 23% were downgraded from decline from a pair status to occupancy by a single owl (USFWS 2009). status on private timber lands, whereas Conversely, on USFS lands 80% of the sites remained occupied by pairs (i.e., original occupancy status did not

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3658 | change(USFWS 2009) ~~did not change pair status~~. These results suggest inefficiency in rules guiding
3659 | timber harvest for the protection of Northern Spotted Owls.

3660 | *Harvest of Hardwood Forests*

3661 | The economic value of tree species growing on timberlands differs, with conifers being generally more
3662 | valuable than hardwoods. The low value of hardwoods historically discouraged their harvest and
3663 | removal from timberlands during commercial harvesting (Merenlender et al 1996). The differential
3664 | retention of hardwoods coupled with aggressive growth of tanoak during early successional processes
3665 | lead many north coast timberlands to be heavily dominated by hardwoods.

3666 | To counter this history, the Forest Practice Rules (CCR 912.7, 932.7, and 952.7) provide timber resource
3667 | conservation standards that require that the percentage of site occupancy by ~~of~~ Group A (generally
3668 | conifers) species ~~to~~ not be reduced relative to Group B species (generally hardwoods) as a result of
3669 | harvest. The Forest Practice Rules specifically require retention of trees of each native commercial
3670 | species inclusive of Group B hardwoods where present at the time of harvest in a limited number of
3671 | silvicultural situations: during the seed step of shelterwood (913.1, 933.1, 953.1 (d)(2)(F)) and seed tree
3672 | (913.1, 933.1, 953.1 (c)(1)(F)) silvicultural systems, and only when applied in the absence of a Sustained
3673 | Yield Plan. The purpose of this retention is to maintain and improve tree species diversity, genetic
3674 | material and seed production, and is achieved by requiring the trees retained ~~leave trees~~ to be of the
3675 | best phenotypes available. These trees need not be retained during the final, removal step. Otherwise,
3676 | the Forest Practice Rules relegate hardwood retention during timber harvest to standards developed
3677 | during plan development and agency review, for example, hardwood must be retained at such a level as
3678 | to such as “Maintain functional wildlife habitat in sufficient condition for continued use by the existing
3679 | wildlife community within the planning watershed” (CCR 897(b)(B)), and as per the “Hardwood Cover”
3680 | evaluation requirements of the Cumulative Impacts Technical Rule Addendum #2 (CCR 912.9, , 932.9,
3681 | 952.9 (c)(4)(e).

3682 | Outside of the timber harvest regulatory arena, some landowners may be actively suppressing
3683 | hardwood competition with the more economically valuable conifers. In these situations, the
3684 | Department has no authority to identify or mitigate impacts by recommending retention standards.
3685 | Some landowners have developed internal standards that they apply during and outside timber harvest
3686 | operations. While these may assure some specimens are retained, presumably providing ~~and~~ some level
3687 | of hardwood function ~~are retained~~ on timberlands, the Department is unaware of the empirical support
3688 | for the efficacy of these levels to provide spotted owl habitat and to support spotted owl forage base.

3689 | *Regulatory Mechanisms Considerations*

3690 | Changes in nesting and roosting habitat and dispersal habitat assessed for the NWFP have provided an
3691 | assessment of broad landscape changes across the range of the Northern Spotted Owl, including
3692 | changes specific to physiographic regions within California. As has been demonstrated at territory-based
3693 | studies of habitat in California and southern Oregon, Northern Spotted Owl habitat is composed of a

Comment [DK65]: Is that the right word? If I understand correctly, what you’re saying is that harvest is continuing around these activity centers via multiple THPs which individually, might not be a big deal, but over time accumulate damage to the NSO home range - right?

If so, how can this happen? Who is evaluating the THPs (state or feds?) and what are the “rules” associated with how much history has to be considered when evaluating a THP?

Comment [DK66]: How is this evaluated and what does it mean exactly? Tallest, largest dbh??

Comment [DK67]: ?? Contradicts previous 2 sentences where you say they did need to be retained.

Comment [DK68]: This is totally subjective isn't it?

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3694 mosaic of mature forests intermixed with younger forest types within the home ranges of individual
3695 owls (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007), with particular
3696 combinations providing high quality habitat. Some of the forest types included in high quality Northern
3697 Spotted Owl home ranges are younger forests, which would have been considered foraging habitat in
3698 the NWFP modeling, and therefore were not assessed for change in the recent review of the NWFP.
3699 Detection of changes in habitat quality at the smaller scale of Northern Spotted Owl home range
3700 requires an assessment of management practices at this scale, and can be accomplished by evaluating
3701 timber harvest practices around known Northern Spotted Owl activity centers.

3702 For core and home range habitat use, studies have documented a more concentrated and frequent use
3703 of habitat features surrounding the activity center (e.g., Hunter et al. 1995, Bingham and Noon 1997,
3704 Meyer et al. 1998, Zabel et al. 2003, USFWS 2009). In addition, the shape of core area use varies due to
3705 the availability of nesting, roosting and foraging habitat, which deviates from the typical circular
3706 representation or core habitat use. The percent of older forest represented within the home range area
3707 varies from 30-60%, with an average of about 45% (USFWS 2009). For a more detailed discussion on
3708 core and home range use, see Biology and Ecology section of this report.

3709 As discussed in the Habitat Requirements section of this report, certain habitat characteristics have been
3710 shown to support high quality Northern Spotted Owl territories, with both the amount and spatial
3711 configuration of different habitat types at a territory contributing to levels of survival and productivity in
3712 the resident owls. This measure of habitat quality at the scale of Northern Spotted Owl home range has
3713 been termed “habitat fitness potential” (HFP; Franklin et al. 2000). See the Habitat Effects on Survival
3714 and Reproduction section of this report for a discussion of HFP and additional studies that have
3715 contributed to an understanding of habitat characteristics that provide high HFP. The studies that have
3716 evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types
3717 that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent
3718 and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

Comment [DK69]: See comment above – I don't think A.F. meant for this metric to be used so literally.

3719 The definition of take under federal ESA includes actions that would reduce the quality of habitat;
3720 therefore, take avoidance recommendations by the USFWS can provide a reasonable baseline to assess
3721 impacts to habitat quality. Estimation of the likelihood of take according to Section 9 of the ESA would
3722 benefit from a better understanding between habitat quality and owl fitness. When the Forest Practice
3723 Rules were originally created, the criteria for owl habitat and retention were based on the best science
3724 and expert opinion at the time and lacked information on reproduction, survival and occupancy.

3725 The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the
3726 Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls
3727 may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis
3728 conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from
3729 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory
3730 loss. They found on private timber lands there was a 54% decline in pair status to no response, and a
3731 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change
3732 pair status. A lack of owl responses and a lack of suitable habitat to support continued occupancy and

Comment [DK70]: This is redundant with discussion above.

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3733 survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early
3734 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat
3735 characteristics to owl fitness, the USFWS asserted that the Forest Practice Rules were insufficient to
3736 adequately avoid take of Northern Spotted Owls (USFWS 2009), although we are not aware of any legal
3737 cases under the current regulatory framework.

3738 To address insufficiencies in the Forest Practice Rules, the USFWS used the results of demography
3739 studies (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005) and additional studies on habitat
3740 selection by Northern Spotted Owl (e.g., Solis and Gutiérrez 1990, Zabel et al. 1993, Irwin et al. 2007), to
3741 develop harvest management guidelines for the interior and coast that would adequately avoid take of
3742 Northern Spotted Owl in California (USFWS 2008b). The purpose of the USFWS guidelines was to enable
3743 CAL FIRE to more effectively and appropriately evaluate THPs and NTMPs to result in timber harvest
3744 activities that do not result in take of owls according to ESA standards. To accompany the guidelines, the
3745 USFWS developed a white paper (USFWS 2009) describing the regulatory and scientific basis for
3746 developing the criteria within the guidance for the interior region of California. The USFWS did not
3747 develop a sister document for the coast region in California. Because criteria in the USFWS 2008
3748 guidelines were developed using the most up to date scientific information for habitat effects on owl
3749 fitness within the core and home range areas, the guidelines differ somewhat from the Forest Practice
3750 Rules. Criteria noted in the Forest Practice Rules Section 919.9 subdivision (g) and the USFWS 2008 and
3751 2009 guidelines are summarized in Tables 20, 21 and 22 below. Definitions of owl habitat referred to in
3752 Forest Practice Rules Section 919.9(g) can be found in Appendix 2.

3753 Among the recommendations in the USFWS guidance to CAL FIRE (USFWS 2008b), minimum amounts of
3754 nesting, roosting, and foraging habitat are described for both 0.5 mile (502 acres; interior forests) and
3755 0.7 mile (985 acres; coastal forests) radius surrounding the activity center, representing the core habitat
3756 use, and for an outer ring of habitat from 0.5 to 1.3 miles radius (2,908 acres; interior forests)
3757 surrounding the activity center, representing broader home range. The USFWS determined that within
3758 the interior forests in California, 0.5 mile radius, rather than the 0.7 mile radius noted in the Forest
3759 Practice Rules, more effectively captured actual core habitat use of Northern Spotted Owls (USFWS
3760 2009). The 2008 USFWS guidelines also revised the definitions of nesting, roosting, and foraging habitat
3761 for the interior, and included differentiation between high quality and low quality habitat (USFWS 2008b
3762 and USFWS 2009). Although assumptions were required in order to develop a single set of guidelines for
3763 the interior forests, the amount and spatial configuration of habitat to be retained is consistent with
3764 what was found in studies that evaluated habitat quality as a function of owl fitness.

3765 When the Northern Spotted Owl guidelines were added to the Forest Practice Rules in 1992, the intent
3766 was to protect Northern Spotted Owls and suitable habitat used for nesting, roosting and foraging. Since
3767 that time, additional scientific literature (e.g., Franklin et al. 2000, Irwin et al. 2000, Zabel et al. 2003,
3768 Courtney et al. 2004, Dugger et al. 2005, Glen et al. 2004, Olson et al. 2004, Irwin et al. 2007) has been
3769 published that helps to further elucidate habitat use of Spotted Owls and associations between habitat
3770 and owl fitness. It is also known that response and occupancy rates have declined at some historical
3771 activity centers. Though the specific reasons why response and occupancy rates have declined are
3772 unknown, there are multiple likely factors including cumulative habitat loss and degradation, and

Comment [DK71]: I don't believe this is true. We have a multitude of studies now that have linked detection rates and occupancy dynamics to BO presence (Olson et al. 2004, Kroll et al. 2010, Dugger et al. 2011, Forsman et al. 2011, and now Dugger et al. 2015). The link to fecundity and survival is weaker, at least up through 2009, but as you'll see in the new meta-analysis results, BO are a big problem for survival too.

Habitat loss has also been directly linked to survival and occupancy dynamics (Forsman et al. 2011, Dugger et al. 2015, other citations you include above), but at least on federal lands, habitat loss has slowed greatly and the BO is having the biggest direct effect.

See Wiens et al. 2010, 2014 too – more on BO/NSO interactions.

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3773 presence of Barred Owl. Given this broad range of possibilities, the Forest Practice Rules may not be
3774 sufficient at protecting loss of Northern Spotted Owl habitat within its range in California.

3775 **Table 20.** Criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted
3776 Owls on private timberlands according to Forest Practice Rules Section 919.9(g).

Forest Practice Rules Subsection	Proximity to Activity Center (acreage)	Criteria Description
919.9(g)(1)	Within 500 feet of the activity center (~18 acres)	Characteristics of functional nesting habitat must be retained.
919.9(g)(2)	Within 500-1000 feet of the activity center (1,000 foot radius circle is ~72 acres)	Retain sufficient functional characteristics to support roosting and provide protection from predation and storms.
919.9(g)(3)	Within a 0.7 mile radius of the activity center (~985 acres)	Provide 500 acres of owl habitat. The 500 acres includes the habitat retained in subsections 919.9(g)(1) and (2) and should be as contiguous as possible.
919.9(g)(4)	Within 1.3 miles of each activity center (~3,400 acres)	Provide 1,336 total acres of owl habitat. The 1,336 acres includes the habitat retained within subsections 919.9(g)(1)-(3).
919.9(g)(5)	Shape of habitat retention	Areas established shall be adjusted to conform to natural landscape attributes such as draws and stream courses while retaining the total area required within subsections 919.9(g)(1) and (2).

Comment [DK72]: I don't disagree with this in principle, but it's hard to make the case when the BO effect is so strong. However, because of the BO, habitat is maybe more important than it was (if that's possible....) given we've now got two species trying to co-exist using the same habitats (see Wiens et al. 2014).

Comment [DK73]: Is this right? Feet not meters? So 167 meters? That seems ridiculously close to the core of an owl territory.

3777

3778 **Table 21.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of
3779 Northern Spotted Owls on private timberlands, and selected stand structural parameters used to classify
3780 nesting/roosting and foraging habitat for Northern Spotted Owls in the northern coastal region of California
3781 (USFWS 2008b).

Habitat Type	Acre Retention in Core Area (within 0.7 mile; ~985 acres) ¹	Acre Retention in Outer Ring (between 0.7-1.3 mile) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	DBH	Percent Canopy Cover	Basal Area
Nesting/Roosting	200 acres	NA	200 acres	≥ 11 inch	≥ 60%	≥ 100 ft ² /acre
Foraging	≥ 300 acres	NA	≥ 300 acres	≥ 11 inch	≥ 40%	≥ 75 ft ² /acre
Suitable Habitat ²	NA	≥ 836 acres	≥ 836 acres			

3782 ¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the
3783 plan.

3784 ² Suitable Habitat is defined as habitat that meets either Nesting/Roosting or Foraging definitions, or a combination of
3785 Nesting/Roosting and Foraging habitat.

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3786 **Table 22.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted Owls on private timberlands,
3787 and selected stand structural parameters used to classify nesting/roosting and foraging habitat for Northern Spotted Owls in the northern interior region of
3788 California (USFWS 2008b and 2009).

Habitat Type	Within 1,000 feet of Activity Center	Acre Retention in Core Area (within 0.5 mile; ~500 acres) ¹	Acre Retention in Outer Ring (between 0.5-1.3 mile; ~2,900 acres) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	Basal Area Parameter	Quadratic Mean Diameter Parameter	Large trees/acre Parameter	Canopy Closure Parameter
High Quality Nesting/Roosting	No timber operations are allowed other than use of existing roads.	100 acres	NA	100 acres	≥ 210 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Nesting/Roosting		150 acres	NA	150 acres	Mix, ranging from 150 to ≥ 180 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Foraging		100 acres	655 acres	755 acres	Mix, ranging from 120 to ≥ 180 ft ² /acre	≥ 13 inch	≥ 5	≥ 40%
Low-quality Foraging		50 acres	280 acres	330 acres	Mix, ranging from 80 to ≥ 120 ft ² /acre	≥ 11 inch	NA	≥ 40%

¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the plan.

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3791 A comparison of the habitat definitions and retention requirements in Section 919.9(g) of the Forest
3792 Practice Rules (Appendix 2 and Table 20) and the revised take avoidance guidance provided by the
3793 USFWS (2009; summarized in Table 21 and 22) reveals how implementation of the Forest Practice Rules,
3794 as written, may result in degradation of habitat quality around Spotted Owl activity centers in the
3795 interior portion of the range. The definition of functional nesting habitat under the Forest Practice Rules
3796 might be adequate to provide suitable nesting or roosting habitat for spotted owls, although the
3797 average stem diameter is less than that recommended by the USFWS. The functional roosting habitat
3798 under Forest Practice Rules does not meet the requirements of roosting habitat under the USFWS
3799 recommendation; habitat falling under the roosting habitat definition would be considered low-quality
3800 foraging habitat under the USFWS recommendations. Functional foraging habitat as defined under
3801 Forest Practice Rules might meet the requirements for low-quality foraging habitat as defined by
3802 USFWS, but does not meet the requirements of foraging habitat.

3803 Under the Forest Practice Rules minimum retention requirements, stands that meet the USFWS
3804 recommendation for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
3805 The habitat retained within 1,000 feet (~72 acres) would be defined as low-quality foraging habitat in
3806 the USFWS guidance. Because the 500 acres of spotted owl habitat to be retained within 0.7 miles and
3807 the total of 1,336 acres to be retained within 1.3 miles of an activity center can be composed of
3808 functional foraging habitat, there is no requirement in the Forest Practice Rules for the retained habitat
3809 within 0.7 or 1.3 miles of the activity center to include nesting or roosting habitat. Also, using the revised
3810 habitat definitions provided by USFWS (2009), this retained foraging habitat could be of low quality.
3811 Although similar acreage of habitat is retained under the Forest Practice Rules and the USFWS
3812 recommendations, very little of the habitat retained under Forest Practice Rules is required to meet the
3813 requirements of nesting or roosting habitat. Consequently, depending on how the rules are
3814 implemented, management could result in a reduction in habitat quality around Northern Spotted Owl
3815 sites and could lead to declines in survival, productivity, and overall fitness.

3816 **Habitat Loss from Marijuana Cultivation**

3817 Large-scale marijuana cultivation in remote forests throughout California has increased since the mid-
3818 1990s, coinciding ~~with the passage of the time~~ the “Compassionate Use Act” ~~was passed~~ in 1996
3819 (Proposition 215) that allows the legal use and growth of marijuana for certain medical purposes (Bauer
3820 et al. 2015). Within the range of the Northern Spotted Owl, Shasta, Tehama, Humboldt, Mendocino, and
3821 Trinity counties comprise the areas known for the most marijuana cultivation in California due to the
3822 remote and rugged nature of the land, making cultivation difficult to detect (National Drug Intelligence
3823 Center 2007, Bauer et al. 2015). Illegal marijuana cultivation grows on public and private land are
3824 widespread in California (Gabriel et al. 2013, Thompson et al. 2013, Office of National Drug Control
3825 Policy 2015), and may also negatively impact owl habitat through degradation and removal, though data
3826 on the extent of this impact is not well known. The Office of National Drug Control Policy (2015)
3827 reported that in 2012 3.6 million plants were eradicated from 5,000 illegal outdoor marijuana grow sites
3828 in the United States, of which 43% were removed from public and tribal lands. Additionally, the USFS
3829 reported that 83% of the plants removed were from California (Office of National Drug Control Policy

Comment [DK74]: How about a potential effect on demographics directly through toxicity associated with herbicides and pesticides? I know there isn't much documented information, but it sounds like the chemicals being used in these groves are pretty heavy duty (and often illegal in the U.S.).

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2015). Areas with higher prevalence of marijuana cultivation may also contain high numbers of Northern Spotted Owl activity centers (see Figure 3), especially in areas where riparian habitat exists.

As discussed previously, for typical timber harvest activities, land owners are bound by the Forest Practice Rules and would therefore need to submit a THP, Spotted Owl Management Plan, Spotted Owl Resource Plan or exemption notification to the appropriate governing agencies. However, small scale timber removal in association with legal marijuana cultivation on private land does not require review or approval from state or federal governments as long as the timber is not sold. Habitat alteration also occurs in association with illegal marijuana grow sites, but the extent is not well known due to the secretive nature of these activities. Therefore, loss of timber and other habitat components important to Northern Spotted Owls (e.g., riparian habitat alterations) for the cultivation of marijuana for such purposes is largely unregulated.

To date, there has been no study that analyzes the impact of marijuana cultivation sites on Northern Spotted Owl habitat or fitness. However, there is a potential for negative impacts of sites placed on private and public land within the owl's range. The level of impact would likely depend on density of cultivation sites in proximity to owl activity centers, and whether sites are placed within suitable owl habitat.

In an effort to assess potential environmental impacts to aquatic ecosystems from legal marijuana cultivation, Bauer et al. (2015) delineated cultivation sites (outdoor plantations and greenhouse locations), using Google Earth satellite imagery from 2011 and 2012, within four watersheds (hereafter referred to as the study area): Upper Redwood Creek, Redwood Creek South, and Salmon Creek, located in Humboldt County; and Outlet Creek, located in Mendocino County. In addition to the Bauer et al. (2015) study area, cultivation sites in the Mad River Creek watershed, in Mendocino and Trinity counties, were also delineated due to interest in identifying potential impacts to aquatic species and water quality in that area. Cumulatively, these 5 watersheds represent approximately 4% of the Northern Spotted Owl range in California (Table 23). Within these watersheds, marijuana cultivation sites varied in size from 0.002 to 2.9 acres and comprised a total of 362 acres. This is a relatively small portion of the watersheds assessed.

Table 23. The number of marijuana cultivation sites within each watershed, and area (acres) associated with each. Watersheds assessed are within Humboldt, Mendocino, and Trinity counties.

Watershed Name	Area (acres)	No. of Cultivation Sites	Total area (acres) of Cultivation Sites
Upper Redwood Creek	155,338	253	43
Redwood Creek South	16,653	369	53
Salmon Creek	23,489	515	42
Outlet Creek	103,554	795	90
Mad River Creek	321,972	416	134

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To assess potential impacts to Northern Spotted Owls we assessed marijuana cultivation locations from 2011 and 2012 within the watersheds mentioned in Table 23, together with owl activity centers locations (Figure 19). We found that no activity centers were within delineated cultivation sites; however, 10 activity centers are within 0.5 miles of the cultivation sites, and 96 within 1.3 miles. Depending on the size of the site and how much suitable owl habitat is removed, impacts to owls may vary. The amount and type of owl habitat removed is summarized in Table 24. For the cultivation sites delineated in 2011 and 2012, much of the habitat removed was unsuitable for Northern Spotted Owls, with the exception of Mad River Creek watershed; here, 12.45 acres of highly suitable, 6.89 acres of suitable, and 22.91 acres of marginal owl habitat was removed.

Table 24. Level of owl habitat removed in each watershed.

Watershed Name	Highly Suitable	Suitable	Marginal	Unsuitable
Upper Redwood Creek	2.67	3.56	22.91	8.9
Redwood Creek South	1.11	1.33	14.90	32.47
Salmon Creek	0.00	0.89	12.23	20.68
Outlet Creek	3.56	5.56	15.35	38.25
Mad River Creek	12.45	6.89	22.91	8.90

As described elsewhere in this report, habitat removal, fragmentation, and degradation can all have varying degrees of negative impacts on spotted owls depending on how much suitable habitat is removed within their core range (e.g., represented by the 0.5 mile buffer surrounding the activity center) and within their home range (e.g., represented by the 1.3 mile buffer surrounding the activity center). Of the 362 acres of forestland or riparian habitat removed for marijuana cultivation, approximately 20 acres are within highly suitable Northern Spotted Owl habitat, 18 acres are in suitable habitat, and 97 acres are in marginal habitat. As an example of potential impacts to Northern Spotted Owl activity centers, Figure 20 shows a zoomed-in area in Humboldt County (at XXX resolution) where marijuana cultivation sites overlap the home range for several activity centers. One activity center displayed in Figure 20 experienced removal of 4.45 acres of highly suitable habitat, 0.67 acres of suitable, 4.45 acres of marginal, and 0.89 acres of unsuitable habitat within the 1.3 mile buffer.

The data used for this analysis comes with certain limitations when assessing long-term impacts to the Northern Spotted Owl. First, the dataset is a snapshot in time during 2011 and 2012 and does not represent expansion of cultivation sites since the data were collected. The data also only covers 4% of the Northern Spotted Owl range and is therefore only representing a small area of potential impact. Marijuana cultivation is occurring outside of the area assessed. To more fully consider impacts a similar analysis would have to be done within the entire range of the spotted owl. In addition, smaller clearings (less than 10 mi²) are likely not captured in the dataset due to difficulties identifying and delineating smaller sites using aerial imagery and not all sites locations are reported as required by law. Sites likely have not been captured for other reasons as well; for example, some sites are intentionally placed in areas where they are harder to detect (e.g., sites with higher canopy closure). Law enforcement efforts and ground surveys/truthing helped fill in the gaps for the data collected in 2011 and 2012, but the

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3893 ~~number of sites unaccounted for is unknown. it is still uncertain how many sites were not accounted~~
3894 ~~for.~~ Lastly, there may be other activities associated with the cultivation sites not captured using this data
3895 that can also have an impact in owl, such as placement of roads and vehicular traffic, or the use of
3896 pesticides and insecticides to increase crop yield.

3897 Given above uncertainties regarding the dataset used in this analysis, it is plausible to assume that the
3898 density of cultivation sites is likely higher than represented in the dataset. In addition, given the density
3899 of cultivation sites within Humboldt, Trinity and Mendocino counties represented in this analysis, and
3900 the fact that the watersheds analyzed comprise only 4% of the Northern Spotted Owl range, it is also
3901 very plausible to assume that marijuana cultivation sites are impacting spotted owl habitat, thereby
3902 likely impacting fitness to some extent.

3903 **Wildfire**

3904 *Effect of Wildfire and Salvage Logging*

3905 Wildfire is a natural process in California's forests, and in much of its range the Northern Spotted Owl
3906 has evolved in a landscape of frequent wildfire. Despite this, fire is often considered a primary threat to
3907 Northern Spotted Owl habitat due the owl's preference for older forests and the capacity of fire to
3908 rapidly remove or degrade habitat. The mature forests preferred by owls for nesting and roosting can
3909 take decades to centuries to develop following removal, depending on location and forest type and fire
3910 severity. The USFWS revised recovery plan (USFWS 2011) considered fire to be a primary threat to the
3911 Northern Spotted Owl, along with ongoing losses to timber harvest and competition with the Barred
3912 Owl. As discussed above, fire has become the primary cause of nesting and roosting habitat loss on
3913 federal lands since implementation of the NWFP, only surpassed by rangewide losses due to timber
3914 harvest, which have been concentrated on nonfederal land (Davis et al. ~~2011~~2015).

Comment [DK75]: I believe the current report essentially concludes the same thing.

3915 The majority of the natural disturbance loss (e.g., disease, insects, wildfires) of nesting and roosting
3916 habitat on federal lands since 1994 has occurred in the five relatively dry physiographic provinces
3917 (eastern Washington, eastern Oregon, and California Cascades; Oregon and California Klamath; Figure
3918 21), with about 86% (211,300 acres) of the natural disturbance loss occurring in these provinces (Davis
3919 et al. 2011).

3920 These dry provinces contain only about 42% of the total nesting and roosting habitat acreage on federal
3921 lands rangewide. Most habitat loss in the dry provinces was due to wildfire in the Oregon and California
3922 Klamath and the eastern Washington and eastern Oregon Cascades (Davis et al. 2011). Degradation of
3923 nesting and roosting habitat from fire was also estimated, with most degradation occurring in the
3924 western Cascades (Davis et al. 2011).

3925 Research on the effect of wildfire on Spotted Owl habitat use and selection, occupancy, and survival has
3926 been conducted ~~throughout the range of the species from~~ in eastern Washington and southern Oregon
3927 for the Northern subspecies, in the Sierra Nevada mountains ~~for in the range of~~ the California Spotted
3928 Owl, and in Arizona and New Mexico ~~in the range of~~ for the Mexican Spotted Owl (e.g., Gaines et al.

Comment [DK76]: Actually very little on the NSO – most on CA owl.

Comment [DK77]: Basically just two studies for northern spotted owl -

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1997, Bond et al. 2002, Jenness et al. 2004, Bond et al. 2009, Clark et al. 2011, 2013). Studies to date are scattered throughout the range of the Spotted Owl and have generally been performed opportunistically due to the difficulties associated with experimental fire research in a natural setting; thus, much uncertainty remains on the effect of wildfires on spotted owl demographics, and the extent and quality of suitable Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates of Spotted Owls has been somewhat equivocal, in some cases showing that stand replacing wildfire has a negative impact on occupancy (e.g., Gaines et al. 1997), and in other cases showing no adverse impact of wildfire on Spotted Owl occupancy (e.g., Jenness et al. 2004). Here we focus on the relatively extensive studies from the Sierra Nevada Mountains in the range of the California Spotted Owl (Bond et al. 2009, Lee et al. 2012, Lee and Bond 2015) and from southwestern Oregon in the range of the Northern Spotted Owl (Clark et al. 2011, 2013), as these areas more closely represent the forest types within the interior range of the Northern Spotted Owl in California and are relatively well studied.

In the southern Sierra Nevada, in areas with a mosaic of burned and unburned forests, California Spotted Owls have been shown to use forests that have experienced a full range of burn severities. Bond et al. (2009) found the degree to which a post-fire site was used varied with burn severity and with the function of the site in meeting various life history requirements (i.e., nesting, roosting, or foraging). This study occurred in an area that experienced the full range of burn severities, resulting in owl territories with a mosaic of all burn classes, ranging from unburned forests to areas with most of the overstory removed by fire (high-severity burn areas were defined as those resulting in high to complete mortality of dominant vegetation; low-severity burn areas were defined as those with little change in cover and little tree mortality; moderate-severity burn areas were those between high- and low-severity, with a mixture of effects on vegetation). Most California Spotted Owl roost sites (85%) occurred in unburned and low-severity burn areas, and owls avoided roosting in moderately and severely burned areas. Conversely, California Spotted Owls selected foraging sites represented by all severities of burned forest and avoided unburned forest (Bond et al. 2009). This study illustrated that California Spotted Owls use multiple forest types within a home range to meet nesting, roosting, and foraging needs, and that moderate to high severity fires may impact preferred nesting and roosting habitat while providing foraging habitat. In contrast to the findings of Bond et al. (2009), recent work on the impact of fire on foraging site selection by California Spotted Owls in Yosemite National Park showed that owls selected for areas of low-severity burns but avoided areas of high-severity burns (Eyes 2014). The owls that were tracked in the burned areas of the southern Sierra Nevada (Bond et al. 2009) were shown to have a diet composed of predominately pocket gophers (Bond et al. 2013), whereas the diet of California Spotted Owls in unburned forests was dominated by woodrats and northern flying squirrels, depending on location. Breeding home range sizes were similar for owls occupying burned and unburned areas (Bond et al. 2013). The apparent shift to an alternative prey source in the post-fire landscape of the Sierra Nevada may have allowed California Spotted Owls to effectively utilize high-severity burn areas and to maintain similar home range sizes.

The use of a diverse forest composition in the Sierra Nevada is consistent with research conducted in the range of the Northern Spotted Owl that indicate high quality habitat is composed of older more mature forest among a mosaic of other forest types (Franklin et al. 2000, Olson et al. 2004). California

Comment [DK78]: A proceedings? Is there actually a document here? Not your best source of information if it isn't published.

Comment [DK79]: See two new ones for CA owl in Sierra's – Lee et al. (2012) Condor: 114, and Lee and Bond (2015), Condor 117

Comment [DK80]: Clarify which subspecies you are referring to and see comment above about Gaines et al. citation.

Comment [DK81]: Update incorporating additional Lee and Bond citations.

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3969 Spotted Owls in the Sierra Nevada also selected for foraging sites that included edge between burned
3970 and unburned forests and between burn areas of different severity classes (Bond et al. 2009). This is
3971 consistent with the above studies on Northern Spotted Owls which showed high quality habitat to have
3972 high amounts of edge between old forests and other forest types.

3973 In a study of post-fire occupancy at six fire sites across the range of the California Spotted Owl in the
3974 Sierra Nevada, Lee et al. (2012) found no difference in occupancy rates between burned and unburned
3975 sites. As with the above study on post-fire habitat selection, this study included fires with a range of
3976 burn severities, which is typical of fires in the Sierra Nevada (Odion and Hanson 2006). Of the six fires
3977 included in the study, on average 32% of the burned area was burned at high-severity so these results
3978 are applicable to mixed-severity fires that result in a mosaic of post-fire conditions. A subset of burned
3979 sites included in the study (9 of 41) burned at higher severity (>50% high severity burn of suitable owl
3980 habitat). Owls were detected at five of these nine sites post-fire (Lee et al. 2012), suggesting that sites
3981 that were exposed to higher amounts of high-severity fire might have experienced reductions in
3982 occupancy, but this was not modeled. Salvage logging of timber after a fire was known to occur on eight
3983 burned sites post-fire. California Spotted Owls initially occupied seven of the eight sites after the fire,
3984 but following the salvage logging none of the sites remained occupied. Post-fire logging may have
3985 adversely affected occupancy of burned sites but the sample size was too small for the effect to be
3986 modeled (Lee et al. 2012). An additional study in the Sierra Nevada compared occupancy rates at 10
3987 unburned sites to 9 sites that burned at low to moderate severity in Yosemite National Park and found
3988 no difference in occupancy rates between burned and unburned sites (Roberts et al. 2011). The study
3989 area was restricted to areas with $\geq 40\%$ canopy cover, and occupancy was positively correlated with total
3990 tree basal area and canopy closure (Roberts et al. 2011). This study did not address effects of high-
3991 severity fire, nor post-fire logging.

3992 In the range of the Northern Spotted Owl, the most extensive evaluation of the effect of fire on owls has
3993 been conducted on a group of three fires in the Klamath and Western Cascades physiographic provinces
3994 of southwest Oregon (Clark 2007, Clark et al. 2011, 2013). By tracking radio-marked owls with territories
3995 inside and adjacent to burned areas, Clark et al. (2011) were able to estimate the effects of fire on
3996 occupancy and survival of Northern Spotted Owls. The occurrence of a demographic study area (South
3997 Cascades) in proximity to the fires allowed for comparison of unburned areas to pre- and post- fire rates
3998 within the fire footprints. On one of the fire study areas (Timbered Rock fire), 22 territories had been
3999 surveyed for ten years pre-fire and so allowed for a comparison of pre- and post- fire occupancy.
4000 Occupancy at this site was compared to the nearby South Cascades study area and the two areas were
4001 shown to have similar trends in occupancy rates prior to the Timbered Rock fire in 2002. However,
4002 extinction rates in the Timbered Rock fire area increased after the fire, resulting in declines in occupancy
4003 (Clark 2007, Clark et al. 2013). Only 20% of territories at the Timbered Rock fire were occupied by a pair
4004 of owls by the end of the study period in 2006 (four years post fire), where >50% of territories had been
4005 occupied in all years pre-fire. These declines were not observed at the unburned South Cascades study
4006 area. Data collected at all three fires from 2003-2006 was used to model post-fire rates and suggested
4007 that high extinction rates and low colonization rates led to declines in post-fire occupancy (Clark 2007).

Comment [DK82]: I would suggest revising and condensing all the information in this entire wildfire section into several paragraphs that highlight what we know about CA and NSO responses to wildfire. Don't just repeat information right out of the discussion of each publication, but synthesize it into a more concise, comprehensive discussion of fire and owls. Maybe organize with a demographics section, habitat use/selection section, and then a "management recommendations" section where information from all relevant studies are presented (for both subspecies combined).

Comment [DK83]: Same comment as above for NSO information.

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4008 On two of the burned areas in southwest Oregon (Timbered Rock and Quartz fires), 23 radio-marked
4009 Northern Spotted Owls were tracked over a one year period in order to estimate survival rates of owls
4010 within and adjacent to burns. Mean annual survival rates of owls displaced by wildfire (0.66 ± 0.14) or
4011 occupying territories within the burned area (0.69 ± 0.12) were lower than those for owls outside of
4012 burned areas (0.85 ± 0.06) (Clark et al. 2011). Survival rates of owls outside of burned areas were similar
4013 to rates at the nearby unburned demographic study area (South Cascades; 0.85 ± 0.01) (Anthony et al.
4014 2006). The two fires included in the survival study each burned about 50% of the owl habitat at mixed
4015 severities from low to high, which is comparable to fires included in studies on California Spotted Owl in
4016 the Sierra Nevada. Of the 24 owls tracked, 5 died during the study. Necropsies were performed on 4 of
4017 these owls and showed that all were severely emaciated and likely died due to starvation (Clark et al.
4018 2011). This, and the fact that owls in the study maintained larger home ranges post-fire (Clark 2007),
4019 suggest that food limitation might have played a role in reduced survival rates. Also, the documented
4020 dispersal of several adult Northern Spotted Owls out of the burn area at the Timbered Rock fire 1-2
4021 years post-fire suggests that insufficient habitat remained at abandoned territories to support an owl
4022 pair (Clark et al. 2013). Both of the fire areas in this study were salvaged logged post-fire, with about
4023 20% of the area logged in each fire. See discussion on potential effects of salvage logging below.

4024 Using the telemetry data collected by Clark in southwest Oregon, Comfort (2013) evaluated selection of
4025 habitats relative to availability following mixed-severity fire disturbance. The strongest predictor of
4026 spotted owl presence was habitat suitability (as defined in the 10-year review of the Northwest Forest
4027 Plan (Davis and Lint 2005)). Northern Spotted Owls avoided large, contiguous patches of high-severity
4028 disturbance and preferentially used areas of lower severity disturbance (Comfort 2013). At small spatial
4029 scales (<0.8 ha), Spotted Owls did select for areas with hard edge created by high severity fire, but at
4030 larger spatial scales, hard edges were avoided. This suggests that at the scale of a home range, owls
4031 selected for large patches of contiguous high suitability habitat interspersed with small patches (<0.8 ha)
4032 of high severity fire or salvage logging (Comfort 2013). Because salvage logging occurred in the study
4033 area on private industry land, the analysis by Comfort did not distinguish between areas of high-severity
4034 burns and those that were salvage logged, but instead used the combined disturbance of fire and
4035 logging to evaluate owl use of different components of the landscape.

4036 An earlier study evaluated short term survival of Spotted Owls following wildfire by tracking color-
4037 banded owls which occurred on territories that later burned in a wildfire during a period from 1985-
4038 2001 (Bond et al. 2002). Because of the opportunistic nature of observations for this study, only 11
4039 territories were included in the study and they were distributed across the range of the species from
4040 California, Arizona, and New Mexico, and represented all three subspecies of the Spotted Owl. Twenty-
4041 one color-banded owls had occurred on the eleven territories pre-fire and 18 were resighted the year
4042 following fire (Bond et al. 2002). This represents a simple annual survival estimate of 86%, which is
4043 similar to reported estimates of survival in unburned areas. The short-term covered by the study (one
4044 year post-fire) and the small sample size limit the utility of the study in extrapolating to a general effect
4045 of fire on Northern Spotted Owls (of which four territories were included), but they do at least
4046 demonstrate that some wildfires have little short-term impact on Spotted Owl survival. Most territories

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in this study burned at low to moderate severity and no salvage logging had occurred between time of fire and the following year when resighting attempts occurred (Bond et al. 2002).

Post-fire declines in occupancy in southern Oregon contrast with most results for the California Spotted Owl in the Sierra Nevada. As mentioned above, two of three burn areas in southern Oregon underwent fairly extensive salvage logging post-fire. The studies conducted in the Sierra Nevada included some sites that were salvage logged, but sample sizes were too small to model the perceived effect of logging on occupancy. Several authors have suggested that salvage logging after a fire or occurrence of extensive high severity burns likely have contributed to a decline in habitat use, occupancy, or survival of Northern Spotted Owls (Bond et al. 2009, Roberts et al. 2011, Clark et al. 2011, 2013, Lee et al. 2012). With the exception of low severity burns, burned areas have generally not supported nesting habitat but have been shown in some cases to create foraging habitat. The presence of snags has been suggested as an important component of prey habitat and as perch sites for foraging Spotted Owls. We do not know of any research conducted on Northern Spotted Owl prey abundance in burned vs. unburned forests, but early successional forests have been shown to support abundant woodrat populations in the southern portion of the range (see discussion of prey in Life History section) and so burned areas may provide high quality prey habitat once vegetation regrowth produces an understory. Bond et al. (2009) concluded that the most likely explanation for high probability of use by foraging California Spotted Owls of forest patches that experienced high severity burns was increased prey promulgated by enhanced habitat conditions, including increased shrub and herbaceous cover and number of snags, and provided the following discussion on the importance of snags to Spotted Owl prey:

“Snags provide shelters for prey species like woodrats and flying squirrels. In the southern Sierra Nevada, dusky-footed woodrat nests are common where shrubs encircle rock outcrops or snags (Lawrence 1966). Bushy-tailed woodrat (*N. cinerea*) densities in dry forests of eastern Washington, USA, were strongly correlated with arboreal and terrestrial cover in the form of large snags, mistletoe, and large soft logs (Lehmkuhl et al. 2006). Northern flying squirrel population densities in Oregon, USA, were correlated with the occurrence of suitable nesting cavities in trees and early decay-stage snags with diameters >50 cm (Volz 1986).”

Lee et al. (2012) argued that snags play an important role in suitable California Spotted Owl habitat in burned areas. This was based on observations that occupancy decreased when ≥20 ha of mature conifer forest was logged within a 400-ha circle surrounding a California Spotted Owl site (Seamans and Gutiérrez 2007), whereas when an average of 32% of suitable habitat within a 400-ha circle burned at high severity no negative effect on occupancy is observed. In southern Oregon, Clark et al. (2013) modeled the effects of fire severity, salvage logging, and pre-fire habitat characteristics on occupancy by Northern Spotted Owls. They found that extinction probabilities increased as the combined area of pre-fire harvest, high-severity burn, or salvage logging increased, resulting in reduced occupancy of nesting territories by Northern Spotted Owls; however, they were unable to distinguish the effect of salvage logging from the other effects (i.e. these factors collectively contributed to declines in occupancy). Observational studies and occupancy modeling conducted to date suggest that post-fire landscapes that are salvage logged experience declines in Spotted Owl occupancy. However, other factors such as initial habitat conditions (e.g., area of pre-fire harvest), the amount and distribution of high-severity fire,

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regional differences in forest composition and fire history, and differential subspecies response may also influence occupancy. Based on results to date that suggest an impact of salvage logging, Bond et al. (2009) recommended that burned forests within 1.5 km of nests or roosts of California Spotted Owls not be salvage logged and Clark et al. recommended restricting salvage logging after fires within 2.2 km of Spotted Owl territories in the range of the Northern Spotted Owl in southern Oregon.

Fire Regime in the Northern Spotted Owl Range

When the USFWS subdivided the range of the Northern Spotted Owl into 12 physiographic provinces, information on fire disturbance regimes was used to inform boundaries (USFWS 1992). Efforts to map the fire-prone portion of the Northern Spotted Owl range since then have generally followed physiographic province boundaries, with the drier provinces of the eastern and California cascades and the Oregon and California Klamath provinces generally considered more fire-prone (e.g., see Rapp 2005, Spies et al. 2006, and Healey et al. 2008). As part of an evaluation of the NWFP, a recent effort to model fire-prone areas used fire history and environmental predictor variables to map the likelihood of large wildfire occurrence throughout the range (Davis et al. 2011). Although this approach did not use existing physiographic province boundaries or other lines used to delineate fire-regimes across the Northern Spotted Owl range to inform the model, results are generally similar to previous descriptions based on broad geographic regions (Figure 22(a)). See Davis et al. (2011) for discussion and potential explanation of differences between model results and previous predictions of fire-prone regions in the eastern and western Oregon Cascades.

~~Regardless of methodology used, A~~ All attempts to map fire-prone areas consistently include large portions of the Northern Spotted Owl range in California, with much of the California Klamath and California Cascades highly prone to fire disturbance. By overlaying the modeling results for fire-prone areas with the Northern Spotted Owl habitat suitability map, Davis et al. (2011) showed that the physiographic province with the most owl nesting and roosting habitat in fire-prone landscapes is the California Klamath Province. This is evident when looking at actual fire history from 1950 to 2013 (Figure 22(b)). Over the last several decades, large acreage fires have been prevalent on the landscape within the Klamath Province.

Within the fire-prone regions of California, fire regimes vary depending on a number of factors, with broad differences noted between the mixed conifer/mixed hardwood forests characteristic of the Klamath Province and the ponderosa pine forests that dominate some portions of the Cascade Province and eastern Klamath Province. The following discussion of historical and current fire regimes in California focuses on these two provinces, as these are the two regions where fire is most likely to have an impact on the Northern Spotted Owl.

Historical Fire Regime in the Klamath Province

As described in the Habitat section of this report, the Klamath Province is an area with extremely high floristic diversity and heterogeneity. This diversity arises from complex patterns in topography, soils, and climate throughout the region, which results in complex vegetation and contributes to a diverse fire

Comment [DK84]: Yes, that was the point. Previous modeling efforts that stuck to “existing” physiographic provinces were underestimating the fire risk in what has been considered more mesic areas. Ray’s modeling approach was really pretty brilliant and matched up very well with observations (i.e., real fire history).

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regime. The natural fire regime acts in a positive feedback manner to contribute to vegetation heterogeneity and diversity (Odion et al. 2004, Skinner et al. 2006). The dominant conifer species across most of the low and mid-elevations in the Klamath Province is the Douglas-fir, and depending on local conditions a wide variety of conifer species may co-occur with this dominant species. At higher elevations, the dominant conifer grades into white fir, and at the highest elevations, a diverse set of subalpine conifer species can occur. Low and mid elevations are characterized by an equally diverse set of hardwood species that form lower canopy layers of mixed conifer hardwood forests and can also occur as pure stands. This occurrence of diverse hardwoods in coniferous forests of the Klamath region may reduce fire severity, and following fire may lead to more rapid recovery by sprouting (Odion et al. 2004, Spies et al. 2006). In drier eastern portions of the Klamath Province, ponderosa pine can be the dominant or co-dominant conifer. Because of the greater extent of ponderosa pine-dominated forests in the California Cascade Province, this forest type is discussed below.

Throughout the Klamath Mountains in the presettlement period most forest stands experienced at least several fires each century, suggesting a mixed fire regime of frequent low- to moderate-intensity fires (Skinner et al. 2006), with low-severity fire composing the largest portion of burned area, and high-severity fire the smallest portion (Agee 1993). Low-severity fire has been defined as those which kill less than 20% of the basal area; high-severity fire causes high tree mortality, with mortality of 70% and above used to define high-severity burns (Agee 1993, Hessburg et al. 2005). Under stable atmospheric conditions, current fires tend to follow a mixed fire regime similar to historical patterns (Taylor and Skinner 1998, Odion et al. 2004). Variation within the mixed-severity fires of the Klamath region has been strongly influenced by topography in both the presettlement and contemporary periods (Taylor and Skinner 1998). As described by Skinner et al. (2006),

“Generally, the upper third of slopes and the ridgetops, especially on south- and west-facing aspects, experience the highest proportion of high-severity burn...The lower third of slopes and north- and east-facing aspects experience mainly low-severity fires. Thus, more extensive stands of multi-aged conifers with higher densities of old trees are found in these lower slope positions. Middle slope positions are intermediate between lower and upper slopes in severity pattern.”

This topographically-controlled fire regime is the most widespread regime in the Klamath Mountains and is controlled by greater heating and drying on certain portions of mountain slopes and climatic variables in deep canyons (Skinner et al. 2006). Temperature inversions that often occur while fires are burning enhance this topographic pattern of fire intensity (Skinner et al. 2006). Historical fires were patchy and relatively small, although fires of up to several thousand acres were relatively common, and the majority of burned areas experienced low and moderate severity fire (Spies et al. 2006). The frequent occurrence of mixed-severity fires created a diverse landscape of older forest with variable openings of younger forest and nonforested areas, with the relative composition of these forest types varying depending on slope position.

Historical Fire Regime in the Cascades Province

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4163 South of the latitude of Mt. Shasta in the California Cascades, the vegetation composition and species
4164 dominance of lower and mid-montane forests is similar to that in the northern Sierra Nevada, and upper
4165 montane forests are more similar to the Klamath Mountains (Skinner and Taylor 2006). Conifer forests
4166 dominate the mid-montane zone on both sides of the Cascade Range and are intermixed with
4167 woodlands and shrublands. On the west side of the Cascades, mixed-species conifer forests dominate
4168 with any of six conifer species co-occurring or sharing dominance (Skinner and Taylor 2006). A
4169 subcanopy of mixed hardwoods may occur beneath the conifer canopy. Extensive areas on the east side
4170 of the Cascade Range are dominated by either ponderosa pine or Jeffrey pine (collectively referred to as
4171 yellow pine; Skinner and Taylor 2006). These forests are less complex than those on the west side with
4172 fewer co-occurring species of conifer and with relatively poor-developed understory historically.
4173 Accordingly, yellow pine-dominated forests had a distinct, more uniform fire regime.

4174 Forest species composition and structure in the different portions of the Cascades Province is related to
4175 fire regime, with areas of mixed-severity fire regimes that occur in the Klamath and portions of the
4176 Cascades frequently supporting multi-storied old growth and the drier forests further east (dominated
4177 by yellow pine) experiencing more frequent, low-severity burns and decreased diversity (Spies et al.
4178 2006). As in the Klamath Mountains, fire-severity in the California Cascades is associated with
4179 topographic position with the high-severity portion of burns more likely to occur on upper slopes and
4180 the low-severity burns occurring predominately on lower slopes. This pattern is less pronounced in the
4181 Cascades than in the more extreme terrain of the Klamath Mountains (Skinner and Taylor 2006). As in
4182 the Klamath region, in regions of the Cascades where fire regime is influenced by topography multi-aged
4183 and multi-sized forests are concentrated on the lower slopes and more even-aged stands that develop
4184 after high-severity burns mostly occurred on upper slopes (Skinner and Taylor 2006).

4185 The portion of the Northern Spotted Owl range which is dominated by ponderosa pine is relatively
4186 uncommon and is distributed in a narrow band on the east side of the Cascades and in limited areas in
4187 southwestern Oregon and northern California (Spies et al. 2006). Jeffrey-pine-dominated forests occupy
4188 the lower elevations on south-, east-, and west-facing slopes in eastside environments (Skinner and
4189 Taylor 2006). These forests occur in the driest portions of the northern spotted owl range. Ponderosa
4190 and Jeffrey pine dominated forests have a distinctly different structure and historical fire regime in
4191 comparison to the mixed conifer forests of the rest of the Klamath and Cascade provinces. Historically,
4192 frequent low-severity burns resulted in low and variable tree densities, with low, patchy developed
4193 understory, and reduced fuel loads (Hessburg et al. 2005). Frequent burns favored fire-tolerant tree
4194 species such as ponderosa pine and maintained fire-tolerant forests by elevating tree crowns and
4195 consuming many small and medium sized trees (Hessburg et al. 2005). The forest structure and
4196 composition in these yellow pine forests that resulted from frequent fires reinforced the occurrence of
4197 low-severity fires by limiting the conditions that could support high severity fires (Hessburg et al. 2005).
4198 Historical open yellow pine forests would not have provided all necessary habitat conditions for the
4199 Northern Spotted Owl, but local areas of high density and complex structure likely provided
4200 requirements for nesting and roosting (Davis et al. 2011) among a landscape of mixed forest types and
4201 nonforest areas.

4202 Recent Changes in Fire Regimes and Possible Causes

Comment [DK85]: See some specific suggestions below, but in general I think this section should be reorganized and condensed to reduce redundancies and improve flow.

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4203
4204 Multiple potential causes have been implicated in increasing fire activity over the last several decades.
4205 The success of fire suppression and exclusion has indirectly advanced secondary succession in forests
4206 and changed forest composition by increasing tree density, decreasing prevalence of fire-tolerant tree
4207 species (e.g., ponderosa pine and Jeffrey pine), and contributing to homogenization of forest structure.
4208 In some cases, timber harvest has directly advanced secondary succession through the selective removal
4209 of the largest trees (Hessburg et al. 2005). Post-harvest tree plantations have created homogeneous
4210 forests dominated by even-aged, smaller-diameter trees that in some cases are less resistance to fire. In
4211 addition, climate variables, including temperature and precipitation, have produced conditions that
4212 promote increased amounts of fire activity.

4213 Beginning in the early 1900s in accessible areas and in the mid-1900s in remote areas, fire suppression
4214 caused a dramatic decline in fire occurrence in the Klamath province (Skinner et al. 2006). The result was
4215 a series of decades, beginning in the early 1900s, with dramatically reduced fire extent over most of the
4216 Klamath region (Taylor and Skinner 1998, 2003; see Figure 23 for example). During this period the fire
4217 rotation (time required to burn an area equal to a defined area of the landscape) increased to an
4218 estimated 974 years in the early 1980s (Miller et al. 2012) compared to a historical estimate for fire
4219 rotation of only 20 years (Taylor and Skinner 2003). In the Cascade Province the fire suppression period
4220 began in the early 1900s. The gentler slopes of the Cascade Province, relative to the Klamath region,
4221 lead to successful fire suppression efforts. This success resulted in a dramatic change in fire frequency
4222 from high frequency low-severity fires to a period of minimal fire occurrence in the California Cascades.

4223 Following several decades of reduced extent and frequency of fire as a result of fire suppression efforts,
4224 the average fire size has increased ~~in recent decades (beginning in the 1980s)~~ across the western United
4225 States ~~beginning in the 1980's~~ (Schwind 2008, Westerling et al. 2006), including the area comprising the
4226 Northern Spotted Owl range in California (Odion et al. 2004, Miller et al. 2012). The area burned
4227 annually within the entire range of the Northern Spotted Owl (Davis et al. 2011) and within the
4228 California portion of the range (Miller et al. 2012) also increased dramatically during this time and the
4229 regional fire rotation ~~declined from a high of 974 years in the early 1980's fell~~ to 95 years by 2008,
4230 ~~(from a high of 974 years in the early 1980s). As noted in Figure 24, the~~ The years between 1970 and 2009
4231 with the most area burned per year in the California portion of the Northern Spotted Owl range have all
4232 occurred since 1987 (Figure 24; Davis et al. 2011, Miller et al. 2012). Mixed-species forests on the west
4233 side of the California Cascades have changed with the success of fire suppression, with forest density
4234 increasing and species composition shifting toward fire-sensitive white fir (Norman and Taylor 2002,
4235 Skinner and Taylor 2006). Although the Cascades portion of the Northern Spotted Owl range in
4236 California has not experienced the number or extent of uncharacteristically large fires that have
4237 occurred in the Klamath province, in recent years several large fires have burned in the eastern Cascades
4238 of Oregon and Washington and in the southern portion of the California Cascades. The gentler
4239 topography of the Cascades is more conducive to extensive fires than the Klamath region (Norman and
4240 Taylor 2003, Skinner and Taylor 2006); where forests have developed high densities of young trees due
4241 to fire suppression, fires that escape fire suppression efforts can become large and burn at high-severity
4242 (Skinner and Taylor 2006).

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Although there is evidence that the increase in fire size in recent years has corresponded with an increase in fire severity in the western U.S., including the Sierra Nevada (Hessburg et al. 2005, Schwind 2008, Miller et al. 2009), trends in burn severity have been less conclusive ~~than trends in fire size and total area burned~~ (Schwind 2008). There is evidence from both the Klamath and Cascade provinces of California that the proportion of fire-severities in recent mixed-severity fires has been consistent with historical patterns, or that change has only been evident in most recent years (Odion et al. 2004, Hanson et al. 2009, Miller et al. 2012).

Some researchers have challenged the common perception that fire suppression and fuel build-up is the main cause of increased fire activity. In their study of large fires in the Klamath Mountains, Odion et al. (2004) evaluated fire history from 1977 to 2002 and concluded that fuel build-up in the absence of fire did not occur, and instead fuel that is receptive to combustion may decrease in the long absence of fire in the study area. ~~These authors also evaluated patterns of burn severity in a nearly 100,000 ha fire that burned in the Klamath Mountains in 1987 to test the effect of fire history, past timber management, and vegetation structure on the extent and severity of current fire. Odion et al. (2004) found that in addition,~~ multi-aged, closed forests generally burned at low severity, even where fire suppression efforts had limited fires over the previous decades, ~~and the same study found that~~ areas with a history of high-severity fire and areas with large amounts of even-aged tree plantations experienced elevated amounts of high-severity fire (Odion et al. 2004). These findings ~~are counter to the common assumption that increased extent of high density forests will lead to increased occurrence of high-severity fire. The additional findings suggests~~ that the historical pattern of mixed-fire regime in the Klamath continues to drive patterns of at least some contemporary fires and can act to maintain diverse, heterogeneous forests (Odion et al. 2004).

~~Miller et al. (2012) conducted a~~ broad assessment of patterns in the extent of high-severity fire ~~was conducted~~ in four national forests of northwestern California (Miller et al. 2012). ~~Their study covered~~ ~~a~~ All fires larger than 100 acres during the years 1910 to 2008 in a 5.8 million acre area including the northern California Coast Range and the Klamath Mountains, as well as a portion of the southern Cascade Range ~~were included in this study~~ (Miller et al. 2012). This study area covers most of the range of the Northern Spotted Owl on federal land in California. Although the authors observed significant increases in both fire size and total annual area burned from 1910 to 2008, they found no temporal trend in the percentage of high-severity fire in recent years.

Despite the findings of Odion et al. (2004) and Miller et al. (2012), at least one recent fire, the Biscuit Fire of 2002, has occurred in the Klamath province that was not only large but was of uncharacteristic high-severity (Skinner et al. 2006). The Biscuit Fire burned about 500,000 acres in southern Oregon and northern California. Almost 224,000 acres (49%) burned at high severity, with 75-100% canopy tree mortality, and an additional 14% of the burn area experienced 50-75% mortality (USFS 2003). This large, relatively high-severity burn was inconsistent with historical burn patterns and was associated with weather conditions that are conducive to fire (i.e., high winds and low humidity). Conversely, in the years when the most area has burned in the Klamath province of California since the 1980s, fires have primarily been caused by region-wide lightning events that strain fire suppression resources and that are associated with more moderate meteorological conditions. Overall fire severities were relatively low in

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4283 these years due to the long duration of fires, weather conditions, and strong inversion events (Miller et
4284 al. 2012).

4285 Steel et al. (2015) presented evidence that the response of fire regime to past fire suppression varies
4286 with forest type and the degree to which fire in an ecosystem is fuel-limited or climate-limited. Forests
4287 with fire regimes that are more fuel-limited (e.g., yellow pine forests and mixed conifer forests found in
4288 much of the interior portion of the Northern Spotted Owl range in California) should experience
4289 increases in fire severity following periods of fire suppression, whereas forests with fire regimes that
4290 have been historically climate-limited (e.g., redwood forests) would be less altered by a history of
4291 suppression. Using data on fire severity for 660 fires that occurred on USFS land in California between
4292 1984 and 2011, Steel et al. (2015) showed that the proportion of fires burning at high severity has
4293 increased for fuel-limited forest types. This increase in severity was correlated to indicators of fire
4294 suppression for much of California; however, the Klamath bioregion did not show this relationship. This
4295 suggests that fire severity, or at least the occurrence of high severity fire in the Klamath bioregion may
4296 be more limited by climate than by fuel loads. This may explain inconsistent observations of fire severity
4297 trends for the Klamath region, with measured proportions of high intensity fire varying on a case-by-
4298 case basis, depending on climatic conditions during the fire.

4299 Where increases in fire size or severity have been observed in recent years in forests of the western
4300 United States, it has often been attributed to increased densities of fuels and development of ladder
4301 fuels as a consequence of fire suppression (citations...). Fire suppression and exclusion in ponderosa pine
4302 forests has been successful at reducing the frequency of fire which allowed for the development of
4303 shade-tolerant trees and understory vegetation in the previously open forests, and resulted in an
4304 increase in stand density (Taylor 2000). Resource-stressed stands are more susceptible to insects and
4305 disease which results in an increase in weakened or dead trees and heavy fuel loadings (Hessburg et al.
4306 2005, Davis et al. 2011). This has led to fuel characteristics in ponderosa pine forests that can support
4307 larger and more severe wildfires (Hessburg et al. 2005). Large, severe fires in the dry eastern Cascades of
4308 Oregon and Washington have occurred in recent years (Davis et al. 2011), and the potential remains for
4309 the loss of large amounts of nesting and roosting habitat.

4310 Past management practices that have established more homogeneous even-aged forests (e.g., fire
4311 suppression, livestock grazing, and timber harvest practices) may provide forest conditions that are
4312 conducive to high-severity fires in forests with fire regimes that were historically fuel-limited (citation?).
4313 Repeated selection cutting of the largest trees had the effect of advancing secondary succession,
4314 resulting in younger forests with higher density, fire-intolerant trees (Hessburg et al. 2005). Recent
4315 large, high-severity fires and timber harvest practices have expanded the amount of even-aged
4316 plantations, hardwood stands, and shrublands (Skinner et al. 2006). Prior to fire suppression, the forest
4317 landscape in the Klamath Mountains contained stands of even-aged forests, but they do not appear to
4318 have occupied extensive areas (Taylor and Skinner 1998, 2003, Skinner et al. 2006). Odion et al. (2004)
4319 reported that plantations occur in one-third of the roaded landscape in their large fire study area in
4320 1987. Extensive areas of young even-aged forests that have resulted from a combination of past fire and
4321 past timber harvest practices may amplify conditions for repeated high-severity fires compared to
4322 heterogeneous forests that were created by historical patterns of mixed-severity fires (Spies et al. 2006).

Comment [DK86]: See previous comment above re: synthesizing (i.e., combining) and condensing information from literature rather than detailing each study. What are the key points – consistency/inconsistency between studies, etc.

Comment [DK87]: This paragraph and this sentence in particular seem out of place here. You introduced research that contradicts this statement with Odion et al. 2004 above, so you should probably discuss this hypothesis and the studies that support it before you present the contradictory research.

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4323 A positive feedback resulting from past timber management and fire suppression practices, existence of
4324 increased even-aged stands in the forest matrix, and future high-severity fire has the potential to
4325 support a new forest matrix with stable or increasing amounts of even-aged forest and decreased
4326 heterogeneity (Skinner et al. 2006).

4327 Several studies have determined a strong link between changes in fire extent, severity and season, with
4328 low precipitation and high temperatures. In addition to land-use history over the last century, climate
4329 variables (e.g., precipitation, temperature) have been evaluated as potential causes of recent increases
4330 in large wildfires. There is an important distinction between these two potential causes. Changes in
4331 forests brought about by land-use history may be reversible through management actions, such as
4332 forest thinning and prescribed fire, while reversing trends in climate warming are unlikely in the near
4333 future (Westerling et al. 2006, Littell et al. 2009). Littell et al. (2009) found that in areas with low fuel
4334 loads the impacts could be lessened through fuel reduction prescriptions, however in areas that are
4335 experiencing low precipitation, this may prove less useful).

4336 Under various climate change scenarios (as discussed in the Climate Change section of this report), fire
4337 seasons have been predicted to be longer and fire sizes larger (McKenzie et al. 2004, Westerling and
4338 Bryant 2008, Littell et al. 2009, Miller et al. 2009, Westerling et al. 2011). For example, McKenzie et al.
4339 (2004) found that extreme fire weather (e.g., hot dry summers) in western America will influence the
4340 severity and the total area burned, with the duration of the fire season lengthened with more fires
4341 occurring early and later in the typical fire season. Westerling et al. (2006) found that periods with large
4342 fire occurrences corresponded with a shift toward warm springs and longer summer dry seasons, and
4343 suggested that both land use and climate have contributed to increased fire risk, but that broad-scale
4344 increases across the western U.S. were driven primarily by recent trends in climate.

4345 Compared to pre-European settlement, Miller et al. (2009) found that high severity fires in low- to mid-
4346 elevation forests are increasing of California and western Nevada. Miller et al. (2009) suggests that snow
4347 water deficits, earlier snowmelt, lengthening of the fire season, worsening drought conditions, low fuel
4348 moisture, and increase of forest fuel availability all play a role in how forests are in a position to burn
4349 more often and at higher severity. In this study, types of forested land most impacted by high severity
4350 fires include those on National Forest land, those experiencing high resource extraction and rapid
4351 human population growth, and those supporting old growth dependent species (Miller et al. 2009).

4352 Another study in the western United States supported theory that climate is a driving factor influencing
4353 fire extent in the 20th century, and fire regimes will vary dependent on fuel energy and water deficits
4354 (Littell et al. 2009). Low precipitation and high evapotranspiration in mountainous ecoprovinces of the
4355 western United States lead to low fuel moisture conditions; thus, creating a system at higher risk to
4356 combustion and fire spreading (Littell et al. 2009). Similar to Miller et al. (2009) findings, Littell et al.
4357 (2009) suggests low precipitation, warmer winters, reduced snowpack and drought effects lead to
4358 increases of forested area burned.

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4359 With future climate change, the continued occurrence of large, uncharacteristically severe fires may
4360 become increasingly common. These changes may in turn impact the habitat, distribution and
4361 abundance of sensitive species such as the Northern Spotted Owl.

4362 Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat

4363

4364 Variation in fire severity has an important influence on forest structural diversity because low-severity
4365 fires kill few trees while high-severity fires may kill all trees in a stand (Taylor and Skinner 2003). High-
4366 severity fires tend to result in even-aged stands while lower severity fires result in forests with multiple
4367 age classes. In much of California, the Northern Spotted Owl evolved in a landscape of frequent, mixed-
4368 severity fire, with most burns occurring at low severity and a relatively small amount of burns occurring
4369 at high severity. In the drier portion of the Northern Spotted Owl range, the species is likely adapted to
4370 the heterogeneous landscape resulting from regular, mixed-severity fire. Prior to fire suppression, the
4371 frequent occurrence of mixed-severity fires in large portions of the Klamath and Cascade ranges, along
4372 with the resulting complex landscape (e.g., older forests with openings of other forest types intermixed
4373 with nonforested areas) was prominent throughout the region. The historical mixed fire regime in the
4374 Klamath region may have benefited Northern Spotted Owl habitat by maintaining areas of older forests
4375 with dense canopies and complex structure, while also providing a heterogeneous landscape composed
4376 of multiple forest ages and structure. This pattern could have supported high quality habitat mosaics of
4377 nesting and roosting habitat and diverse foraging habitat which lead to high survival and reproductive
4378 success (Franklin et al. 2000).

Comment [DK88]: Yes, but “historically” there was much more “suitable” NSO habitat, and thus, larger populations, but also the ability to move around a bit more if/when an area burned. So any negative effects of fire (either acute or chronic) could be more easily buffered. Therefore, talking about “adaptations” to fire by NSO really means considering historic habitat availability, population level responses, as well as the behavior of individuals and being adapted to heterogeneous landscapes is still only helpful if there ultimately, enough “suitable” habitat available to buffer individuals and/or populations when things burn.

4379 Current fire regime and its potential to impact Northern Spotted Owl habitat depends on a number of
4380 factors including: habitat availability, fire management history, logging history, forest type, historical fire
4381 regime, weather patterns and climate change. Additionally, observed impact to Northern Spotted Owl is
4382 likely complicated by occurrence of post-fire salvage logging (citations?). Although forest heterogeneity
4383 has decreased with recent management practices, the forests of the Klamath Mountains continue to
4384 provide habitat for Northern Spotted Owl. Thus, mMore information is needed on the effect of historical
4385 fire suppression and current fire regimes on the amount and quality of current owl habitat, especially on
4386 the quality of habitat as assessed through demographic rates on at individual owl territories. Most fires
4387 in the Klamath region continue to burn under historical mixed regimes that can contribute to a
4388 heterogeneous forest landscape (citation). However, recent large fires are cause for concern for the
4389 future stability of forest conditions in the region, especially considering the higher percentage of
4390 remaining suitable owl nesting and roosting habitat experiencing high-severity burns. Large amounts of
4391 Northern Spotted Owl nesting and roosting habitat has been lost to wildfire since implementation of the
4392 NWFP, with the majority being lost in a few very large fires (e.g., the Biscuit Fire of 2002) (Davis et al.
4393 2011). Fires have been more frequent during dry years (Cook et al. 1996) and extreme weather events
4394 influence the occurrence of large, landscape-scale fires (Miller and Urban 2000). Wildfire has been the
4395 leading cause of nesting and roosting habitat loss on federal lands in recent decades; if large fires
4396 continue to occur in the future, much more habitat may be lost.

Comment [DK89]: See above – important to stress that fire is a concern because so much NSO habitat has been lost (to harvest mostly) – so whatever ability NSO had to buffer the effects of large fire by moving around, increasing home range sizes, or even just taking a direct hit to survival for a small group of birds, is lost now that so little habitat remains and owl populations are so small.

Comment [DK90]: “Large” overstates things. The greatest loss of owl habitat has been to fire, but that loss is still very low (<3%).

4397 Historical fire suppression and exclusion in ponderosa pine forests in the Cascades was successful at
4398 reducing the frequency of fire which allowed for the development of shade-tolerant trees and

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understory vegetation in the previously open forests, and resulted in an increase in stand density (Taylor 2000). This may have improved nesting and roosting habitat conditions for Northern Spotted Owls in these forests compared to the pre-suppression period (citation??). However, high densities of younger trees as a result of fire suppression and timber management practices have created conditions with potential for stand-replacement fires in ponderosa pine forests. Ideally a landscape-scale management strategy for these forests would retain large, dense patches of forests embedded in a matrix with reduced stand densities to limit the potential for stand-replacement fire and competitive pressure on old trees (Thomas et al. 2006).

Comment [DK91]: This paragraph seems out of place – either delete or move up and combine with previous discussion of fire frequency, etc., in dry forests.

With the complexity of fire regimes in the state California, the sometimes-equivocal effects on Northern Spotted Owl habitat use and demographics, the uncertain contribution of fuel build-up, and climate influences on future fire frequency and severity, there has been disagreement on the level of risk that fire poses in the dry portions of the Northern Spotted Owl range. Hanson et al. (2009) reported-contend that the risk of fire to Northern Spotted Owl habitat in the dry provinces had been overestimated in the 2008 Recovery Plan, which included ongoing loss of habitat as a result of timber harvest and fire as threats to the Spotted Owl (USFWS 2008a). This claim of overestimation was made-based on calculated rates-estimates of old-forest recruitment (in ha) that exceeded ng ratesamounts of old-forest burned in of high severity fire in old-forests (Hanson et al. 2009). However, Spies et al. (2010) contend that criticized the findings of Hanson et al. (2009), stating that an incorrect threshold, with higher classification errors than were reported was used to estimate the extent of high severity fire and that an incorrect depiction of error was used to support selection of the threshold. Spies et al. (2010) also disagreed with the methodology used by Hanson et al. (2009) to estimate the that assumptions used to estimate rate-of recruitment of old-forests were not justified.

Comment [DK92]: The direct comparison is between number of hectares recruited vs. number of hectares burned (Table 1 in Hanson et al. 2009).

This debate on the risk of fire to Northern Spotted Owl habitat has important management implications. If recent and projected changes in fire size or severity continue to remove large amounts of nesting and roosting habitat, fuel treatments (e.g., thinning and prescribed fire) to reduce fire risk may have long-term benefits to owls by encouraging the development and maintenance of older forest patches while limiting the risk of stand-replacing fires. However, if recent large high severity fires are an anomaly and recruitment of old forest outpaces losses to high severity fire, natural processes can be incorporated into management plans to shape Spotted Owl habitat on the dry province landscape. Hanson et al. (2010) recommended small-scale experiments to study owl response to fuel treatments rather than large-scale implementation. Risks are not likely to be uniform across the range, with ponderosa pine forests likely having a different response to past management than mixed-conifer forests of the Klamath, for example. The 2011 Revised Recovery Plan recommends formation of working groups to inform management in both the Klamath and dry Cascade provinces (USFWS 2011a).

Comment [DK93]: We currently have no idea what effect these management activities have on NSO demographics.

Climate Change

According to global and regional climate scenarios, many species will be required to adapt to changes in temperature, precipitation, forest structure, etc., or face eminent declines or extirpation. The degree of threat varies based on species and region. Climate change scenarios have been modeled across the

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range of the Northern Spotted Owl, including in California. Several studies have been conducted to assess the threat to Northern Spotted Owl specifically.

Climate Change Projection Modeling

In California, a multitude of climate change studies have been conducted with a resulting – As noted by Pierce et al. (2012), a common theme among the California-specific studies indicates that suggests temperature will generally increase, showing a consistent positive trend, but changes in but changes in precipitation vary by location across the state (Pierce et al. 2012). Generally, most studies agree that California will retain its Mediterranean climate of cool/wet winters and hot/dry summers, yet the degree of wetness/dryness will likely be amplified (Lenihan et al. 2003, Cayan et al. 2012).

The projected climate model simulations from Cayan et al. (2012) exhibit warming over California, with a mid-century rise of approximately 1°C to 3°C (1.8°F to 5.4°F), and 2°C to 5°C (3.6°F to 9°F) rise by end-of-twenty-first century. Pierce et al. (2012) showed an average yearly increase in temperature over California of 2.4°C by the 2060s, with coastal areas showing less warming (1.9°C) than interior areas (2.6°C). Westerling and Bryant (2008) predicted an average increase of 4.3°C in California by 2070–2099. Seasonally, the summer and fall months exhibit greater warming than winter and spring months (Cayan et al. 2012, Pierce et al. 2012), with the degree of warming increasing as one moves from the coast to the interior of the state (Cayan et al. 2012). Extreme temperature events (i.e., frequency of extreme hot days) will become more common place and may take place earlier in the season (Cayan et al. 2012).

Climate projection modeling conducted by Cayan et al. (2012) show a high degree of variability between month-to-month and year-to-year precipitation with slight drying tendencies in some areas of California, which may suggest that California will remain at risk to drought and flooding events, with more prominent changes in the southern portion of the state than the northern portion. Seasonal changes in precipitation included a somewhat contracted wet season, with less precipitation during late winter and spring than during the core winter months (Cayan et al. 2012). Pierce et al. (2012) found precipitation decreased overall in the southern portion of California (<10%) by the 2060s, but remained unchanged from historical levels in the northern portion of the state. Seasonally, winters in the northern portion of the state were wetter and offset by drier conditions the rest of the year by the 2060s, while the southern part of the state showed moderate decreases in fall, winter, and spring but stronger increases in summer (Pierce et al. 2012).

Dalton et al. (2013) summarizes climate projection models for the Coastal, Cascade and Rocky Mountain ranges of Washington, Oregon and Idaho (e.g., Northwest). This paper indicates that the region showed an overall increase of temperature year-round (warming of at least 0.5 °C (0.9 °F) in every season), but more prominent warming during summer months. Modeling showed mixed results for annual precipitation, indicating little change from present (models ranged from –4.7% to +13.5%). Seasonally, most models showed a decrease in precipitation during summer months and increased precipitation during the other seasons (the largest projected change of about –30%). Dalton et al. (2013) climate models are in agreement that heat extremes will increase and cold extremes will decrease. Along the

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Northwest coast, sea level rise was projected to rise 4 to 56 in (9–143 cm) by 2100, with significant local variations.

Climate Change Impacts to Forests

In the Northwest and in California, changes in precipitation and temperature may impact forest distribution, growth, and structure (Lenihan et al. 2003, Dalton et al. 2013, Vose et al. 2012, McIntyre et al. 2015). Most climate projection models indicate upward elevational shift and a northward latitudinal shift in forest habitats (Vose et al. 2012). In climate projection scenarios specific to California, [Lenihan et al. \(2003\)](#) noted the most notable [predicted](#) response to increased temperature was a shift from conifer-dominated forests to mixed conifer-hardwood forests in the northern half of the state (e.g., the replacement of Douglas fir-white fir forest by Douglas fir-tan oak forest in the northwest), and an expansion of conifer forests into the northeast portion of the state (e.g., Modoc Plateau) by the 21st century ([Lenihan et al. 2003](#)). [A comparison of current forest structure and composition in the last decade to historic data \(1930's\) suggests these predicted shifts are already occurring](#) [McIntyre et al. \(2015\) found similar results when comparing historic forest survey data \(1930s\) with recent surveys \(2000s\) to elucidate forest structure and composition shifts over time](#) within the entire latitudinal extent of forests in California ([McIntyre et al. 2015](#)). [This study found that today's](#) [Currently](#) forests in California are exhibiting an increased dominance of oaks (*Quercus*) at the expense of pines (*Pinus*). [McIntyre et al. \(2015\) also found that](#) and across the a 120,000km² study area, large trees declined by 50% with a 19% decline in average basal area and associated biomass since the early 1900s ([McIntyre et al. 2015](#)). Understanding the shifts in structure and species composition is complex, but [McIntyre et al. \(2015\)](#) [may be](#) partially attributed [these shifts](#) to water deficits within California forests (e.g., drought), [while acknowledging along with](#) other contributing factors such as logging and fire suppression (McIntyre et al. 2015). Conifer-dominated forests (e.g., redwood and closed-cone pine forests) along the north-central coast of California (e.g., Crescent City south to Monterey) [were are](#) projected to advance, resulting in redwood forests shifting inland, [replacing into current](#) Douglas-fir-tan oak forests (Lenihan et al. 2003). [In general](#) [Dalton et al. \(2012\) found that](#) Douglas-fir forests [throughout in](#) the Northwest may experience substantial declines through the 21st century ([Dalton et al. 2012](#)). Tree productivity along California's north-central coastal and at high elevation forests [was shown to has](#) increased in response to increased growing season temperatures; however, increased in productivity along the coast [can would only occur be seen if there was a persistence of](#) coastal summer fog [persists](#) (Lenihan et al. 2003). [Lenihan et al. \(2003\) suggests that](#) if summer fog were to decrease in conjunction with increased temperatures, productivity of redwood forests along the coast would [suffer reductions decline](#), or worse, [would this forest type may](#) be eliminated entirely ([Lenihan et al. 2003](#)).

Vulnerability to disturbance, such as wildfire, disease and insect outbreaks, is expected to increase in most forests in the Northwest and may change forest composition and structure depending on changes to climate (Dalton et al. 2012, Vose et al. 2012). [According to Davis et al. \(2011\),](#) [One of the objectives of US Forest Service is to develop projections for wildfire regimes and habitat shifts due to changing climate and increased threats from wildfire, disease and insect outbreaks](#) ([Davis et al. 2011](#)). [Vose et al.](#)

Comment [DK94]: Reorganize and condense by "theme" rather than by study? Maybe a section on temperature, then another for precip?

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(2012) effectively summarizes the nationwide effects of climate driven disturbance can be summarized as follows (Vose et al. 2012):

- Frequency and extent of wildfire will increase, resulting in a doubling of area burned each year (?) by mid-21st century.
- Insect infestations (e.g., bark beetle in the western US) will expand
- Invasive species will likely become more widespread, and especially in areas with increased disturbance and in dry forests.
- Increased flooding, erosion and sediment transport will increase due to ~~caused by~~ increased precipitation, increased size of wildfire burn areas ~~of large burned areas~~, and increased rain-snow ratios.
- Increased occurrence of ~~s in~~ drought will ~~occurrences~~, exacerbating other disturbances (e.g., fire, insect outbreaks, invasive species), which will ~~leading~~ to higher tree mortality, decreased regeneration in some tree species, and alteration of tree species composition and structure.

Comment [DK95]: Increase? i.e., there will be more of them or more trees affect, Or do you mean expand in distribution (greater area affected), or both?

Climate modeling studies agree that forest wildfire occurrence and severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and longer drier summers (Swetnam 1993, National Assessment Synthesis Team 2000, Houghten et al. 2001, Lenihan et al. 2003, Westerling et al. 2006, Westerling and Bryant 2008, McKenzie and Littell 2011, Vose et al. 2012). Spracklen et al. (2009) projected that forests of the Pacific Northwest forests will experience increases in mean annual area burned, with a projected increase of 175% by 2050 compared to areas burned between 1996 and 2005. This increase will likely negatively impact old-growth forests and the species that inhabit them (Dalton et al. 2012, Vose et al. 2012). By evaluating fire history and climatic data in forested areas across the western United States over a 34-year period, Westerling et al. (2006) tested the contributions of land use and climate conditions on occurrence of large fires. Over this study period, the frequency and size of wildfires showed a marked increase in the mid-1980s; a large portion of this increase occurred in the range of the Spotted Owl in California (Sierra Nevada, southern Cascades, and Coast Ranges of northern California). The period of increase in large fire occurrence corresponded with a shift toward warm springs and longer summer dry seasons and (Westerling et al. 2006). ~~The authors concluded that both~~ land use and climate have contributed to increased fire risk; however, but that broad-scale increases across the western U.S. were driven primarily by recent trends in climate (Westerling et al. 2006). For California as a whole, by the end of the 21st century, risk of large fire will increase between 12 and 53 percent compared to observed fire regimes between 1980 and 1999, and for northern and southern California, large fires will increase 15 to 90 percent and -29 to 28 percent, respectively (Westerling and Bryant 2008). See the Wildfire section above for more detailed discussion on wildfire impacts to forest systems.

Climate Change Impacts to Northern Spotted Owl

Northern Spotted Owls utilize older structurally complex forests, in part, to facilitate thermoregulation and to provide protection from predators. Forest type and age within owl habitat varies by region. Coastal regions are wetter and cooler and tend to be redwood species dominant and of a younger age

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4551 class, whereas inland regions are drier and warmer and tend be mixed conifer/hardwood or Douglas-fir
4552 dominant.

4553 Most climate projection scenarios agree that the forests in the Northern Spotted Owl’s range will have
4554 wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased
4555 frequency and intensity of disturbance events. According to many climate projections, the frequency
4556 and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will
4557 increase over time. Extreme climatic variation has been linked to sudden large-scale mortality in avian
4558 populations in the past (Tomba 1971, Johnson et al. 1991, and Smith et al. 1991 as cited in Franklin et al.
4559 2000), and the literature studying Spotted Owl response to climate supports this.

4560 Northern Spotted Owl survival is thought linked to precipitation patterns. Olson et al. (2004) stated that
4561 survival was negatively associated with early-nesting season precipitation, and positively associated with
4562 late-nesting season precipitation. Population growth for Northern Spotted Owls range-wide
4563 (Washington, Oregon and California) was positively associated with wetter conditions during the
4564 growing season (May through October) due to more favorable conditions for prey species, but
4565 negatively associated with cold/wet winters and nesting seasons, and during hot summers on four of the
4566 six study areas (Glenn et al. 2010). Over the extent of late-successional reserve land covered by the
4567 NWFP, Carroll (2010) predicted that winter precipitation was closely associated with a decrease in
4568 Northern Spotted Owl survival and recruitment (i.e., the entirety of the Northern Spotted Owl range in
4569 Oregon, Washington and California). Using vegetation and climate variables, model results in Carroll
4570 (2010) predicted an initial northward expansion of high quality owl habitat, followed by a contraction as
4571 climate variables intensify over time.

4572 In the Coastal and Klamath Mountains of northwestern California, Franklin et al. (2000) thoroughly
4573 examined the effects of climate on temporal and spatial variation of Northern Spotted Owl survival,
4574 reproductive output, and recruitment. In these models, climate explained most of the temporal
4575 variation in life history traits. The study suggested that the period most impacted by climate was during
4576 the spring, presumed largely due to higher energetic demands during the breeding season, as well as
4577 prey abundance and availability. Franklin et al. (2000) states, “extreme climate conditions during the
4578 early nesting period may exacerbate an energetic stress on an individual by decreasing it’s time to
4579 starvation.” However, the winter period did explain variation in recruitment, thought to be a function of
4580 reduced survival of young during their first year.

4581 In Oregon and Washington, Glenn et al. (2011) found a negative association between Northern Spotted
4582 Owl reproduction (number of young fledged) and cold wet nesting season, thought to be a function or
4583 loss of eggs or young to exposure or terminating incubation (Forsman et al. 1984). Whereas,
4584 reproduction was positively associated with late nesting season precipitation and negatively associated
4585 with warm temperatures, thought to be a function of reduced prey abundance and availability.
4586 Interestingly Glenn et al. (2011) also found that number of young fledged per year declined when
4587 precipitation in the year prior deviated from normal, and that number of young fledged per year
4588 increased following warm wet dispersal seasons. Some of these results differ from California studies
4589 such as Franklin et al. (2000), and may be a function of differing habitat, climate and targeted prey

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4590 species. Regardless, the study suggests that Northern Spotted Owl reproductive success involves a
4591 complex relationship between prey populations, body condition and climate prior to and within the
4592 nesting season; a statement that, given the current literature on the species, certainly holds true for the
4593 species in California.

4594 The literature also indicates that Spotted Owls are sensitive to heat stress (Franklin et al. 2000,
4595 Weathers et al. 2001), which may be more problematic as temperatures rise over time. For the
4596 California Spotted Owl, Weathers et al. (2001) found that when temperatures reached between 30 and
4597 34°C, a relatively moderate level, owls increased behavioral heat responses (e.g., increase respiratory
4598 rate, gaping, wing drooping).

4599 As previously discussed, structural complexity (broken top trees, snags, overhead cover) is an important
4600 habitat component for Northern Spotted Owls. Structural complexity is an important factor in
4601 determining the availability of suitable nest sites. Rockweit et al. (2012) found that nest type selection
4602 played a role in Northern Spotted Owl reproductive success in California during period of inclement
4603 weather (i.e., low temperatures and high winds). Nests that were more exposed to the elements, such
4604 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at
4605 protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must
4606 include structurally complexity to provide nesting options with proper protection. The intensity of
4607 disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or
4608 detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced
4609 when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may
4610 increase the level of structural complexity.

4611 Habitat loss and alteration due to heightened disturbance events (e.g., wildfire, disease, insect
4612 outbreaks), may also impact forest species, such as the Northern Spotted Owl, by intensifying
4613 competitive pressure from other species, such as Barred Owl (Lenihan et al. 2003, Carroll 2010).

4614 Direct mortality of Spotted Owls from wildfire will likely increase as frequency and intensity of wildfires
4615 increases. Indirect impacts may also include an increased level of predation if there is loss of older or
4616 structurally complex forests. However, neither direct mortality nor increased predation is specifically
4617 addressed in the literature.

4618 To better understand potential climatic impacts to Northern Spotted Owls, the Department compiled
4619 average 30-year (1980-2010) and 5-year (2010-2014) precipitation and temperature data and calculated
4620 the percent change within the owls range. Decreases in precipitation were most apparent in the
4621 southern portion of the coastal range (Marin, Sonoma and Mendocino counties), and within the interior
4622 range (Figure 25). Increases of precipitation were more limited, with increases seen in a small portion of
4623 northern Trinity County, and scattered within Humboldt and Del Norte counties. This analysis generally
4624 shows a drying trend throughout the owl's range, except in the northern portion of the coastal province
4625 and some small portion of the Klamath province.

4626 Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-
4627 August) and winter months (December-February) separately. Comparing the 30-year average with the 5-

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year average, temperature increases during the summer months were seen mostly within the north and northwest portions of Siskiyou County (northern portion of the Klamath and Cascade provinces), and along scattered portions of the coastal province (Figure 26). As shown in Figure 26, temperature decreases in the summer months were seen most prominently within the rest of the interior (Klamath and Cascade provinces). During the winter months, temperature increases were seen within interior (Klamath and Cascade provinces), while decreases were seen most prominently in the coastal province (Figure 27). This analysis generally shows warmer winters and cooler summers compared to normal within the interior portion of the Northern Spotted Owl range, and cooler winters and warmer summers along the coastal portion of the range.

It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many climate projections forecasting steady changes in the future. Climate change studies predict future conditions that may negatively impact owls, such as wet and cold springs, more frequent and severe summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased frequency of severe wildfire events. Yet in some instances predicted future conditions, such as increased frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other areas of the range. Looking at past precipitation and temperature trends, drying trends across most of the owl's range in California coupled with warmer winters and cooler summers in the interior and cooler winters and warmer summers along the coast may play a role in both owl and prey population dynamics. More research is needed to assess the extent of these climate impacts on survival, population growth and reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of climate change outweigh the positive ones.

Barred Owl

Barred Owl Expansion and Current Status in California

Historically, Barred Owls were residents of the eastern United States and southern Canada, east of the Great Plains and south of the boreal forest, and also in disjunct regions of south-central Mexico (Mazur and James 2000). Based on genetic analysis, Barrowclough et al (2011) found the disjunct Mexican populations to be distinct from populations in the United States and Canada at the species level, and recommended they be recognized as *Strix sartorii*. Barred Owls continue to occupy their historical range, and during the past century have expanded their range into western North America.

The timing and route of the Barred Owl range expansion into western North America has been debated, ~~with by the scientific community and is not resolved.~~ An early and long-held view has been that Barred Owls expanded their range to the west via the boreal forests of Canada (Grant 1966, Hamer 1988, Houston and McGowan 1999, Holt et al. 2001). A slightly different version suggests the expansion began via riparian forests of the Missouri, Yellowstone, and Musselshell rivers of the northern Great Plains to the forested mountains of western Montana at the end of the 19th century (Figure 28); -Livezey

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(2009a) suggested a slightly different pattern of expansion based on records for more than 12,500 Barred Owl detections from 1873 to 2008. He suggested that the expansion began via riparian forests of the Missouri, Yellowstone, and Musselshell rivers of the northern Great Plains to the forested mountains of western Montana at the end of the 19th century (Figure 28). From Montana, he suggests that Barred Owls then expanded their range in multiple directions, including to the north and then east, where they encountered Barred Owls that were expanding their range west through the boreal forests of Canada. Regardless of whether the initial range expansion was via the boreal forest of Canada or the riparian corridors of the northern Great Plains, once Barred Owls reached British Columbia in the 1940s, they continued their range expansion to the north and west across Canada to southeastern Alaska, and south through Washington, Oregon, and California (USFWS 2011a, USFWS 2013). The range of the Barred Owl now completely overlaps the range of the Northern Spotted Owl from southwest British Columbia south along the western portion of Washington, Oregon, and northern California, and also includes a significant portion of the range of the California Spotted Owl.

Barred Owls were first detected in California in 1976 (Dark et al. 1998, B. Marcot in Livezey 2009a). From then until 1996, 61 Barred Owl sites were identified in California (Dark et al. 1998). The majority of these sites (73%) were occupied by single owls. The first report of breeding in California was in 1991 (T. Hacking in Dark et al. 1998) and the first sighting in the Sierra Nevada was in 1991. The rate of detections of Barred Owls in California accelerated during the mid-1990s (Dark et al. 1998) and by 1996 Barred Owls had been detected as far south as Sonoma County in western California and Yuba County in the Sierra Nevada. Forsman et al. (2011, Appendix B) presented data showing that the rate of detection continued to accelerate through the 2000s. Currently, the known range of the Barred Owl in California extends along the coast south to Marin County (Jennings et al. 2011, Ellis et al. 2013) and to Tulare County in the Sierra Nevada.

The Department has processed data for 1,970³ Barred Owl occurrences in California (Figure 29), and 111 additional occurrences of Barred-Spotted Owl hybrids. Occurrences include all detections of barred owls, whether or not they were associated with a nest or territory.

Following the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two species have occasionally been observed. The majority of hybrids genetically sampled resulted from a cross between a female Barred Owl and a male Spotted Owl (Haig et al. 2004, Kelly and Forsman 2004). Generally, second generation hybrids are generally difficult to distinguish from barred-Barred or Spotted Owls using field identification only, and genetic samples may be the only sure way of identification (Kelly

³ The 1,970 occurrences processed to date represent a subset of available data and come from 2 general sources: 1) state and private researchers, biologists and foresters from 1978-2013 and 2) the Forest Service's NRIS database with records from 1992-2011. Data omitted due to time constraints includes 1) hard copy data, 2) 2012-2013 NRIS detections and 3) NRIS detections that were within 1 mile of processed data to avoid duplicates; this data, not including duplicates, will be added in the future. An updated version of NRIS containing 2012 and 2013 detections is still needed. Additional data from the 2013 field season is also yet to be submitted. There is likely more data in holding and data from additional sources that has not been submitted.

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and Forsman 2004). ~~Although the two species DNA sequences are largely divergent and can be separated into distinct clades with no signs of previous introgression (Haig et al. 2004).~~ Both first and second generation hybrids were found to be reproductively viable to some extent (Kelly and Forsman 2004). ~~Haig et al. (2004) found that the two species DNA sequences showed a large divergence and could be separated into distinct clades with no signs of previous introgression.~~

Potential Mechanisms of Barred Owl Range Expansion

Factors that may have facilitated the range expansion have been debated in the literature at length. As mentioned above, two possible routes for the initial expansion from eastern North America have been suggested (i.e., riparian forests of the northern Great Plains and the boreal forest of Canada). It has been speculated that an ecological barrier existed prior to the end of the 19th century and that changes, either anthropogenic or natural, removed the barrier, and allowed for the initial westward expansion of the Barred Owl range.

Comment [DK96]: Citations?

The most prominent theory is that an increase in the number of trees and forested areas supported the expansion by providing suitable Barred Owl habitat where before there was none (e.g., within the Great Plains). The relatively fast Barred Owl range expansion coincides with a period of dramatic increases in wooded habitat across the northern Great Plains and the boreal forests of Canada following arrival of European settlers. ~~Possible e~~Explanations for an increase in the number of trees are anthropogenic and include fire suppression, tree planting (including shelterbelts), extirpation of bison, and to a lesser extent reductions in beaver, elk and deer populations on the northern Great Plains due to market hunting (Dark et al. 1998, Wright and Hayward 1998, R. Gutiérrez in Levy 2004, Livezey 2009b). ~~Livezey (2009b) evaluated the plausibility of barriers to range expansion that have been proposed. He provided strong evidence that the northern Great Plains were largely treeless prior to the range expansion, a finding that supported a lack of habitat as a potential barrier. He also evaluated a number of anthropogenic changes (as noted above) preceding or coincident with the expansion and that are likely to have greatly increased the forest habitat in the region. Livezey concluded that the most plausible explanation for an ecological barrier that existed prior to range expansion, the removal of which coincided with range expansion, is an increase in forest habitat, first along the rivers and later in the boreal forest. Tree planting and fires suppression are obvious causes of the increase in wooded area, and the timing of these precedes the expansion of Barred Owl to the west. Huge numbers of bison destroyed small wooded areas on the Great Plains through rubbing on older trees and browsing or trampling of young trees (Livezey 2009b). The extirpation of bison precedes the increase in wooded habitat on the northern Great Plains. Elk, deer, and beaver have also been shown to have local effects on forest habitat, and may have contributed to suppression of forests in the Great Plains, especially in the limited wooded habitat along riparian corridors (Livezey 2009b).~~

Comment [DK97]: I don't think you need to go into so much detail here – lay out the theory and appropriate citations and leave it at that.

Another ~~theory hypothesis proposes is t~~that increased ~~s~~ in temperatures may have improved habitat value for Barred Owls in the northern boreal forest (Johnson 1994, Wright and Hayward 1998, Monahan and Hijmans 2007). This theory is based on an assumption that the boreal forests of southern Canada were too cold to be tolerated by Barred Owls, and that a warming climate brought these forests into the

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range of temperature tolerance for the species, thereby eliminating a natural barrier to Barred Owl range expansion ~~(citation?)~~. ~~However, Because~~ portions of the current range of Barred Owls (e.g., northern Alberta and British Columbia, the Northwest Territories) are much colder than the forests of southern Canada, ~~and the temperature increases reported to support this hypothesis occurred after the Barred Owl range expansion began (Johnson 1994, Monahan and Hijmans 2007), the thermal barrier hypothesis seems unlikely~~. ~~Livezey (2009b) rejected the hypothesis that a thermal barrier was preventing range expansion, but he suggests conducting additional research on the thermal tolerances of Barred Owls. Additionally, the temperature increase referenced in the literature occurred in part after the Barred Owl range expansion had begun (Johnson 1994, Monahan and Hijmans 2007), calling this mechanism of range expansion into question.~~

Once Barred Owls expanded across the middle of the continent, they encountered forests of the Rocky Mountains and the Pacific Northwest. Timber harvests may have facilitated the further expansion of the range by creating a mosaic of more open forest habitat that might be favored by a habitat generalist like the Barred Owl (Hamer et al. 1989, Dark et al. 1998). However, Barred Owls have become established in a variety of habitats, including mature forests that have not been harvested, ~~challenging this as a factor in the further expansion of the range~~ (USFWS 2013). Because Barred Owls are habitat and prey generalists (as explained below), the suggestion that they adapted to use of a novel (coniferous forest) habitat, which then allowed them to spread through the boreal forest and the forests of the west has largely been dismissed (Livezey 2009b, USFWS 2013).

Spotted Owl and Barred Owl Habitat, Prey Selection, and Home Range

Barred Owls tend to select low to high elevation areas with gentle slopes, large overstory tree with expansive crown diameter, and evergreen stands with a dense canopy, but will also nest in areas with young trees, deciduous tree species and open areas (Herter and Hicks 2000, Buchanan et al. 2004, Gremel 2005, Hamer et al. 2007, Jennings et al. 2011, Mazur and James 2000, Pearson and Livezey 2003, Singleton et al. 2010). ~~In western Oregon, Recently, Wiens et al. (2014) determined that~~ Barred Owls selected a broad range of forest types ~~in western Oregon~~, but were more strongly associated with large hardwood and conifer trees within relatively flat areas along streams (Wiens et al. 2014). In the eastern Cascades Range in Washington, ~~Singleton (2015) found~~ Barred Owls used structurally diverse mixed grand fir and Douglas-fir forests during the breeding season more often than open ponderosa pine or simple-structure Douglas-fir forests, with less selection among forest types during the non-breeding season (Singleton et al. 2010, 2015). Spotted Owls may have a stronger affinity than Barred Owls to Douglas-fir dominant forests and more abundant dwarf mistletoe infestations, an important habitat feature for nesting Spotted Owls in the Washington's eastern Cascades (Singleton 2015). Similarities between Barred Owl and Spotted Owl habitat preferences include selection of old forests with closed canopy and a high degree of structural complexity for nesting and roosting activities (Mazur et al. 2000, Singleton et al. 2010, Wiens et al. 2014, Singleton 2015). ~~As Wiens et al. (2014) points out, t~~The similar habitat preference for older forests highlights the importance for maintaining this forest type on the landscape because a decrease in older forests will likely increase competitive pressure between the two species (Wiens et al. 2014). Differences ~~in of~~ habitat selection include the tendency for selection of

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lower elevation sites with gentle slopes (e.g., valley floors) by Barred Owls, the use of a larger variety of forest types by Barred Owls, the stronger dependence on Douglas-fir dominant forests by Spotted Owls, and more abundant mistletoe infestations by Spotted Owls ([citations? Wiens et al. 2014, Singleton 2015](#)). Currently, there is no indication that the two species can [partition forested habitats or that Barred Owls won't successfully use all the habitats preferred by Spotted Owls \(Gutiérrez et al. 2007, Dugger et al. 2011, Singleton 2015\)](#). Thus, because these two species ~~coexist~~ share ~~ing~~ the same habitat and prey-base, ~~and because~~ there is little evidence that nesting habitat or ~~prey-base~~ [food resources](#) can be adequately partitioned to prevent competition, [coexistence of both species is uncertain \(Gutiérrez et al. 2007, Dugger et al. 2007, Wiens et al. 2014, Singleton 2015\)](#). ~~(Gutiérrez et al. 2007, Dugger et al. 2011, Singleton 2015)~~.

Home range analyses show the importance of mature forests for nesting by both Barred and Spotted Owls; however, Barred Owls select other forest cover types similar to their availability whereas Spotted Owls are more tightly associated with old forests (Hamer et al. 2007, Singleton et al. 2010). Home ranges for both species have been found to be smaller in old mature forests; however, within forest types, home ranges of Spotted Owls are 3 to 4 times larger than those of Barred Owls (Hamer et al. 2007, Singleton et al. 2010, Wiens et al. 2014). In a western Oregon study, Barred Owl home range and core area use (i.e., the portion of the fixed-kernel breeding season home range in which use exceeded that expected under a null model of a uniform distribution of space-use) was 581 ha and 188 ha, respectively; whereas Northern Spotted Owl home range and core area use was much larger - 1843 ha and 305 ha, respectively (Wiens et al. 2014). In some areas of sympatry, little overlap exists between Barred and Spotted Owl home ranges, which is indicative of competitive exclusion of Spotted Owls by Barred Owls (Hamer et al. 2007, Singleton et al. 2010). However, ~~Wiens et al. (2014) found 81% overlap~~ between the two species with adjacent territories [was observed](#) in western Oregon ~~to be 81%~~, with most space sharing [observed](#) in the foraging areas outside of the core area ~~(Wiens et al. 2014) use~~.

Barred Owls are opportunistic hunters that consume a wide array of prey, including small mammals ranging from rabbits to bats, small to medium sized birds, amphibians, reptiles, fish, and invertebrates; however, mammals make up a majority of prey items (Hamer et al. 2001, Mazur and James 2000). [Conversely, Northern Spotted owls rely on a much more specialized prey base, comprised primarily of small mammals, making them more of a generalist than Spotted Owls in their selection of prey \(Wiens et al. 2014\)](#). Hamer et al. (2007) measured a ~~diet-Diet~~ overlap by biomass [between Spotted and Barred Owls was of as much as 76% between Spotted and Barred Owls](#) in a region of sympatry in the Cascades of Washington [\(Hamer et al. 2007\), although more moderate in western Oregon \(41%; Wiens et al. \(2014\) found dietary overlap by biomass between the two species to be moderate \(41%\) with Northern flying squirrel, woodrat and lagomorph species the primary prey for both \(84% of Northern Spotted Owl diet and 49% of Barred Owl diet\). Both studies suggest competition for food resources between the two species.](#)

Prey species composition and density drive habitat selection and home range size for both owl species; however, Spotted Owls are more sensitive to fluctuations in prey abundance and availability than Barred Owls due to their more limited number of preferred prey species (Bond et al. 2013, Franklin et al. 2000,

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4813 Hamer et al. 2007, Meyer et al. 1998, Thomas et al. 1990, Ward 1990, Zabel et al. 1995, Zabel et al.
4814 2003, Wiens et al. 2014). The narrow range of prey selected by Spotted Owls contributes to the need
4815 for much larger home ranges in comparison to Barred Owls.

4816 *Impacts of Barred Owls on Spotted Owls*

4817 Data is lacking to adequately assess Barred Owl abundance in western North America. However,
4818 Northern Spotted Owl populations are declining throughout most of their range. The USFWS holds
4819 periodic workshops with Northern Spotted Owl researchers to assess population parameters, such as
4820 abundance, trend and survival (USFWS 2013). Regularly conducted meta-analysis These workshops
4821 incorporating long-term demographic data for up to 14 study areas across the range of the owl have
4822 resulted in four-five published and one unpublished meta-analyses since 1994 (Burnham et al. 1994,
4823 1996, Franklin et al. 1999, Anthony et al. 2006, and Forsman et al. 2011, Dugger et al. in press). These
4824 analyses show that in areas where Barred Owls are present, the decline in Northern Spotted Owl
4825 abundance has been steeper than where the Barred Owl was absent. Declines were more prevalent
4826 where Barred Owls density was greatest. In addition, analyses determined that Northern Spotted Owl
4827 adult survival declined in a majority of the study areas in Washington, Oregon, and California where
4828 Barred Owls were present, with a more gradual decline in California sites (Forsman et al. 2011). The
4829 relatively lower rate of decline in California may be attributable to the relatively more recent Barred Owl
4830 expansion into California. The presence of Barred Owls in or near Spotted Owl territories appears to be
4831 impacting the abundance, fecundity, and survival of Spotted Owls (Olson et al. 2004, Forsman et al.
4832 2011). Wiens et al. (2014) found annual survival for Northern Spotted Owl in western Oregon lower
4833 (0.81, SE=0.05) than that of Barred Owl (0.92, SE=0.04), with a strong positive relationship on survival to
4834 old forests (>120 years) for both species. Northern Spotted Owl reproduction increased linearly with
4835 increasing distance from Barred Owl territory centers, and all Northern Spotted Owl nests failed when
4836 within 1.5 km (0.93 miles) of a Barred Owl nest (Wiens et al. 2014).

4837 The expansion of the Barred Owl range into that of the Spotted Owl has been documented mainly
4838 through incidental detections during Spotted Owl surveys. Based on these detections, numerous
4839 researchers have reported that Barred Owl numbers quickly increase after a short period of slow
4840 increase once they arrive in a new area (USFWS 2013; Anthony et al. 2006, Forsman et al. 2011, Dugger
4841 et al. in press). In the Oregon Cascades, Barred Owl detections increased from one initial detection in
4842 1979 to over 700 detections by 1998 (Kelly 2001). Barred Owls can also quickly outnumber Spotted
4843 Owls; in the Northern Cascades in Washington, Barred Owl abundance was twice that of Spotted Owls
4844 within 17 years of the first detection (Hamer et al. 1988). In the range of the Spotted Owl, the density of
4845 Barred Owls is greatest in the north, where they have been present the longest (British Columbia and
4846 Washington), and fewer detections have been made in the southern edge of the range (California)
4847 where they have been present for a shorter duration (USFWS 2013). Despite this general north-south
4848 gradient in the density of Barred Owls, Forsman et al. (2011) provide strong evidence of increasing
4849 Barred Owl populations throughout the range of the Northern Spotted Owl and California Spotted Owl.

Comment [DK98]: This is incorrect. The USFWS does not hold these workshops and the citation given refers to the EIS regarding BO removals experiment – which wouldn't be appropriate here (at least that's the citation in the Lit Cited).

The meta-analysis workshops are held frequently (<every 5 years early on, then every 5 years since 1998) to evaluate the trends and status of NSO relative to the implementation of the Northwest Forest Plan (see Forsman et al. 2011 Intro for good history – also Chapter 2 in Davis et al. 2011). These workshops are led and organized by one of the Lead PI's on the demographic monitoring areas (i.e., Franklin, Anthony, Forsman, and now Dugger). The Forest Service funds this workshop, and the USFWS is very interested in our results, but the USFWS is not driving this process – in fact I'm not even sure they ever kick in money – to either the monitoring program or the workshop specifically. The FS and BLM are the funders and primary entities interested in performance of owls under NWFP.

Comment [DK99]: Unpublished report.

Comment [DK100]: Should be published by the time you get to revisions – so will be 2015.

Comment [DK101]: Not all – we've only looked at BO effects since the 2004 meta-analysis (i.e., Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2015)

Comment [DK102]: No, this isn't exactly correct.

Basically, we've linked BO presence primarily to survival in Anthony et al. 2006, Forsman et al. 2011, and Dugger et al. In press. What's new this time around is the really strong link with extinction rates rangewide, within the occupancy analysis – so populations are declining through declines in survival and extinction rates, both of which have been linked to BO presence on many of the 11 study areas included in meta-analysis. We don't have really strong direct links between BO present and annual rates of decline – just the mechanisms (survival and extinction rates) that result in those population changes. Other studies that have documented BO effects on extinction rates include Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011.

Comment [DK103]: I think you'll need to revise this section after reviewing Dugger et al. in press.

Comment [DK104]: See graphs in appendices that show BO presence in all study areas over time.

Comment [DK105]: I'd replace this with more current data from Appendix C, Dugger et al. in press – you can note how much of an increase there has been on some study areas in the number of territories where BO are detected each year – in particular in southern Oregon and N. CA.

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4850 Barred Owl presence has also been determined to be negatively associated with Spotted Owl occupancy
4851 throughout the range of the Northern Spotted Owl (Olson et al. 2005, Kroll et al. 2010, Forsman et al.
4852 2011, [Yackulic et al. 2012, 2014](#), [Sovern et al. 2014](#)). ~~Studies have shown that~~ Barred Owl presence
4853 [negatively](#) influences whether Spotted Owls occupy a territory (Kelly 2001, Pearson and Livezey 2003,
4854 Gremel 2005, [Olson et al. 2004](#), [Kroll et al. 2010](#), [Dugger et al. 2011](#), [Yackulic et al. 2012, 2014](#), [Sovern et](#)
4855 [al. 2014](#)). In Olympic National Park, an area with historic Northern Spotted Owl territories, occupancy of
4856 Spotted Owls declined by almost 20 percent as Barred Owl presence increased by 15 percent between
4857 1992 and 2003 (Gremel 2005). ~~It has also been determined that~~ Spotted Owl [activity centers](#) will [shift](#)
4858 [move activities](#) away from areas ~~where it~~ [Barred Owls are present](#) ~~ee~~ even if they do not [entirely](#)
4859 [abandon](#) ~~move~~ their territory (Kelly 2001, Gremel 2005). Within the Hoopa Valley Indian Reservation
4860 (Humboldt County, California), Barred Owls were detected in over 85% of all historic Northern Spotted
4861 Owl territories between 2009 and 2014 (Higley and Mendia 2013). Northern Spotted Owl occupancy in
4862 the Hoopa study area started a steep decline in 2004, in concert with a boom in Barred Owl occupancy;
4863 and in 2013, [Northern Spotted Owl occupancy was down to 0.595 while Barred Owl occupancy](#)
4864 [increased to 0.838 \(95% CI\) \(Higley and Mendia 2013\).](#)

Comment [DK106]: Doesn't telemetry data from Wiens et al. 2014 also suggest this?

4865 [For the Willow Creek Study Area \(part of the NWC study area\), Franklin et al. \(2015\) reported a mean \$\lambda\$](#)
4866 [of 0.975 \(1985-2014; SE 0.012\), indicating a decline in the Northern Spotted Owl population for this](#)
4867 [area. The mean survival rate was 0.848 \(1985-2014; SE 0.009\). Survival rate was thought to be](#)
4868 [negatively influenced by the presence of Barred Owl. The Willow Creek Study Area has experienced a](#)
4869 [dramatic increase in Barred Owl detections, from one barred owl site in 1991 to 22 in 2014 \(Franklin et](#)
4870 [a. 2015\). Spotted Owl territories having Barred Owl detections ranged between 0-37 within the same](#)
4871 [timeframe \(Franklin et al. 2015\).](#)

Comment [DK107]: Be careful – were these estimates of occupancy incorporating detection rates (i.e., MacKenzie et al. type models?) if not, these numbers are under-estimates and should be reported as “apparent” or “naïve” estimates of occupancy.

4872 When Barred Owls were first detected in a Northern Spotted Owl territory on Green Diamond Resource
4873 Company land, Humboldt County, Northern Spotted Owls no longer responded to taped playback calls,
4874 demonstrating they were either absent from the territory or not responsive (Diller 2012). In 2014, there
4875 were [268 Barred Owl detections on Green Diamond Resource Company land, representing an estimated](#)
4876 [65 territories, and demonstrat](#)[inges a 76% increase in detections from 2011-2014 \(GDRC 2015\). Forty-](#)
4877 [eight of the 65 territories were within the density study area \(GDRC 2015\).](#)

Comment [DK108]: This is now available as published information in Dugger et al. in press.

4878 [Barred Owl removal experiments were conducted on Green Diamond Resource Company land to assess](#)
4879 [the impacts Barred Owls were having on Northern Spotted Owl presence \(Diller 2012 and GDRC 2015\).](#)
4880 [When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within](#)
4881 [13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that](#)
4882 [some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to](#)
4883 [Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed](#)
4884 [\(Diller 2012\).](#)

Comment [DK109]: See additional information re: demographic responses of removals on GDR (in particular lambda) – rest of the removal experiment on GDR is currently undergoing review with JWM.

4885 During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley
4886 Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97%
4887 adults, 92.9% female, 65.3% male), with at least one Barred Owl removed from 28 historic Northern

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4888 Spotted Owl territories, and >2 removed from 21 Northern Spotted Owl territories (Higley 2014).
4889 Spotted Owl occupancy since the removal has occurred has not yet been reported.

4890 Spotted Owls will reduce their calls or not call at all if Barred Owls are in the vicinity (Cozier et al. 2006,
4891 Diller 2012, Sovern et al. 2014), making it more difficult to detect Spotted Owls if Barred Owls are
4892 present. Thus, standard surveys might result in occupancy status being misclassified (e.g., a false-
4893 negative survey -- designating sites as unoccupied by Spotted Owls when in reality Spotted Owls are
4894 present but are not vocalizing). Beyond land management implications (e.g., timber harvest or not), this
4895 behavior shift by the Spotted Owl may also have implications for reproduction because calls are used to
4896 defend a territory and locate mates, and during pair bonding and prey delivery to the nest site (USFWS
4897 2013).

4898 The ecology of Barred Owls gives them a competitive advantage over Spotted Owls regarding
4899 reproductive success and productivity (Courtney et al. 2004, USFWS 2013). Barred Owls have larger
4900 clutches (1 to 5 chicks) than Spotted Owls (1 to 3 chicks), and Barred Owls may produce up to three
4901 clutches per season, both of which may lead to higher productivity (Gutiérrez et al. 1995, Mazur et al.
4902 2000, Gutiérrez et al. 2007). Some studies have found that Spotted Owls often do not breed every year,
4903 and that productivity varies from year to year (Forsman et al. 1984, Mazur et al. 2000, Rosenberg et al.
4904 2003, Forsman et al. 2011, [Dugger et al. in press](#)).

4905 The literature suggests that Barred Owls are displacing Northern Spotted Owls from their territories, and
4906 Spotted Owls are forced into lower quality breeding and foraging habitat (USFWS 2013, Sovern et al.
4907 2014). In addition, detecting Spotted Owls during surveys is likely hindered because Spotted Owls
4908 vocalize less often when Barred Owls are nearby (Crozier et al. 2006). Displacement and reduced
4909 vocalizations are thought to negatively impact Spotted Owl productivity (Forsman et al. 2011). As
4910 discussed previously, Barred Owls are prey generalists and Spotted Owls are prey specialists; a factor
4911 that may play into reproductive success (USFWS 2013).

4912 Barred Owls are aggressive toward Spotted Owls, and have attacked Spotted Owls on occasion.
4913 Courtney et al. (2004) reported several instances where Spotted Owls were attacked by Barred Owls,
4914 and where surveyors were attacked by Barred Owls while playing Spotted Owl calls. Leskiw and
4915 Gutiérrez (1998) suspected that a Barred Owl killed and partially consumed a Spotted Owl. Johnston
4916 (2002, as cited by Courtney et al. 2004) presented evidence that a Barred Owl likely killed a juvenile
4917 Spotted Owl. It is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities
4918 were due to territorial aggression (USFWS 2013). By comparison, instances reported of Spotted Owl
4919 aggression toward Barred Owls are few (George and Lechleitner 1999, A. Ellingson, pers. comm, P.
4920 Loschl, pers. comm as cited in Courtney et al. 2004).

4921 Lewicki et al. (2015) sampled blood from Northern Spotted Owls and western Barred Owls throughout
4922 Siskiyou, Trinity, Humboldt, and Mendocino counties in an attempt to evaluate parasite dynamics and
4923 the related impacts of Barred Owl range expansion on spotted owls. Specific results related to parasite
4924 prevalence are noted within the Disease section of this report below. The study suggests that parasite
4925 dynamics in Northern Spotted Owls are not solely influenced by the presence or absence of Barred

Comment [DK110]: This is a not really the appropriate citation – cite the primary literature, so Olson et al. 2004, Kroll et al. 2010, Dugger et al. 2011, etc.,

Comment [DK111]: You stated this already above -

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4926 Owls, but that more research is needed to assess roles of additional factors relating invasion to
4927 host/parasite dynamics (Lewicki et al. 2015).

4928 The literature suggests that Barred Owls have impacted Northern Spotted Owls in a variety of ways,
4929 including reduced survival and occupancy, displacement, reduced detection rates, and predation. In the
4930 northern portion of the Northern Spotted Owl range, where Barred Owls have existed longer and are
4931 more densely distributed, the realized negative impacts are severe. In California, where Barred Owl
4932 occurrences are relatively recent, the negative impacts are less severe at this point. However, in
4933 portions of the northern California range where Barred Owls have become more common in recent
4934 years, impacts to Northern Spotted Owls, including displacement and declines in occupancy and survival
4935 rates, have been observed.

Comment [DK112]: Not true – see Dugger et al. 2015. In last 5 years, BO impacts in S. OR and CA have increased – this is important as CA pops were stable (or close to it) based on Forsman et al. 2011, but they are now declining.

4936 Disease

4937 The 2011 Revised Recovery Plan (USFWS 2011a) states, “It is unknown whether avian diseases such as
4938 West Nile virus (WNV), avian flu, or avian malaria... will significantly affect Spotted Owls.” Likewise,
4939 disease occurrence in Spotted Owls is likely under-reported because Spotted Owls tend to inhabit
4940 remote areas and, therefore, there is a small likelihood of carcass recovery for testing (K. Rogers,
4941 personal communication, September 25, 2014).

4942 In California, two studies have investigated the prevalence of WNV in raptor populations (Hull et al.
4943 2006, Hull et al. 2010). In migrating and wintering hawks, Hull et al. (2006) found of the 271 red-tailed
4944 hawks, 19 red-shouldered hawks, and 30 Cooper’s hawks tested, WNV antibodies were present in 5-58
4945 percent. However, no individuals that tested positive demonstrated any visible signs of illness.
4946 Conversely, WNV antibodies were not detected in 62 Northern goshawks, 209 Spotted Owls, and 22
4947 great gray owls sampled in the Sierra Nevada, suggesting low prevalence or high mortality in these
4948 species (Hull et al. 2010). Only one recent case of WNV infection was reported in a dead California
4949 Spotted Owl in 2013 from the Sierra Nevada (K. Rogers, personal communication, September 25, 2014).

4950 Research conducted elsewhere in North America, suggests WNV infection causes morbidity and
4951 mortality in several species of raptors. In Colorado, WNV infection was highest in red-tailed hawks and
4952 great-horned owls (compared to other raptor species) admitted to wildlife rehabilitation centers; clinical
4953 signs were variable and included emaciation, weakness, and inability to perch, fly, or stand (Saito et al.
4954 2007). Additionally, 40 of 56 dead raptors, evaluated for WNV, were tested positive; histological lesions
4955 most often included encephalitis and myocarditis (Saito et al. 2007). In Georgia, 40 out of 346 raptors
4956 tested for WNV were positive, including 4 Barred Owls, one great horned owl, and four eastern screech
4957 owls (Ellis et al. 2007). All 40 cases occurred during summer and late fall (Ellis et al. 2007), when
4958 mosquito activity is most common. Gancz et al. (2004) investigated an outbreak of WNV in several
4959 species of captive owls in Ontario, Canada, including one Spotted Owl and eight Barred Owls. Owl
4960 species with more northerly breeding ranges (e.g., snowy owl, great gray owl) showed higher rates of
4961 infection than more southerly breeding species (e.g., barn owl, eastern screech owl) (Gancz et al. 2004).
4962 WNV infection in these captive birds was found to coincide with a summer louse fly infestation,
4963 suggesting bites from the louse flies aided in WNV transmission (Gancz et al. 2004). Additionally, there is

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evidence that raptors can become infected with WNV after feeding on infected prey (Nemeth et al 2006). WNV infection is routinely identified in squirrels (Family: Sciuridae) (Padgett et al. 2007), as well as jays and other songbirds (Hull et al. 2010; Wheeler et al. 2009) in California; the range of these species may overlap with that of Northern Spotted Owls, possibly posing an additional infection risk.

Other diseases that may impact Spotted Owls are largely unknown at this time. There are no documented known studies or cases of mortality caused by avian (flu) influenza in Spotted Owls. According to Rogers pers. comm. (2014), The prevalence of avian influenza in the spotted population is expected to be low since the disease is primarily carried by waterfowl and shorebirds, two groups that have low interaction with Spotted Owls (Rogers, pers. comm 2014). In addition, little information is available on the prevalence of avian malaria or Leucocytozoonosis (both blood parasites) in Spotted Owls and significant mortality of avian species due to these blood parasites avian malaria or Leucocytozoonosis is rarely reported in avian species (K. Rogers, personal communication, September 25, 2014), with the exception of island endemics or birds in captive situations. In these cases, and most infected birds seem to recover or may have chronic infections that do not impact fitness or survival (citation??). Impacts of parasitic infection to Northern Spotted Owl survival are also unknown. However, Martinez et al. (2010), documented lowered survival of wild breeding female blue tits (*Cyanistes caeruleus*) in Spain infected with *Haemoproteus* parasites (*Haemoproteus* and *Leucocytozoon* spp.).

There are a handful of studies that have documented blood and intestinal parasites in owl species. Ishak et al. (2008) tested 111 Spotted Owls, and 44 Barred Owls, and 387 owls of nine other species for Leucocytozoon, Plasmodium, and Haemoproteus spp. (haemosporidian blood parasites). The study found both California and Northern Spotted Owls carried the greatest number of Leucocytozoon parasite lineages, California Spotted Owls had a higher prevalence of infection with more multiple infections than Northern Spotted Owl, and Barred Owls along the coast had lower rate of infection (15%) than Northern Spotted Owls (52%) and California Spotted Owls (79%). They suggested that the greater infection load of Spotted Owls compared to Barred Owls may favor the later in competitive interactions. Interestingly, Ishak et al (2008) documented the first ever case of Plasmodium infection in a Northern Spotted Owl. Gutiérrez (1989) tested 105 Spotted Owls (seven populations and all subspecies) for hematozoa (a blood parasite) and found all to be infected with at least one hematozoan. This study suggested that the owls large home range, spanning various forest types, the time spent caring for and provisioning young, and their long life span make this species more susceptible to higher rate of infection compared to other bird species (Gutiérrez1989). From 2008 to 2012 blood samples were analyzed from Northern Spotted Owls (n=98) and western Barred Owls (n=49) throughout Siskiyou, Trinity, Humboldt, and Mendocino counties and tested for blood parasite loads (Lewicki et al. 2015). For comparison, blood samples were also analyzed from eastern Barred Owls (n=135) housed in wildlife rehabilitation centers throughout their historic range. Lewicki et al. (2015) found *Haemoproteus* spp. infection prevalence higher in Northern Spotted Owl (76.5%) than western Barred Owl (30.6%), and highest in eastern Barred Owl (88.1%), and infection intensity was nearly 100 times greater in Northern Spotted Owl than western Barred Owl. The study did not directly evaluate the impacts of blood parasite infections on the owl species assessed (Lewicki et al. 2015).

Comment [DK113]: I'm not sure you need to go into so much detail here – there is currently little evidence that WNV is having a serious impact on NSO – despite early concerns that it may become a problem. I would suggest having a discussion with Alan Franklin, as I believe he was doing some work on the issue in CA.

Comment [DK114]: I think this is the point right? Birds can carry the blood parasites with no apparent clinical symptoms?

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5003 In Oregon, Hoberg et al. (1993) reported enteric coccidia (intestinal parasite) in a juvenile female
5004 Northern Spotted Owl. The presence of the parasite did not appear to contribute to the juvenile Spotted
5005 Owl's death; however, death has been attributed to this type of parasite in other raptor species (Hoberg
5006 et al. 1993). In this case study, transmission was thought to be through consumption of infected small
5007 mammal prey (e.g., mice, squirrels, woodrats). Trichomonosis is a concern for Spotted Owls if they
5008 consume Columbids infected with the protozoan parasite, *Trichomonas gallinae*, where species ranges
5009 overlap. The Department's Wildlife Investigation Lab documented two cases of Trichomonosis in
5010 California Spotted Owl in 2012, two cases in Northern Spotted Owl in 2014 from the Coastal Mountain
5011 Range, north of San Francisco Bay, and one in a great gray owl in 2006 and in 2007 (K. Rogers, personal
5012 communication, September 25, 2014).

5013 In northwestern California, Young et al. (1993) found Hippoboscids flies on 62 of the 382 Northern
5014 Spotted Owls captured over five years between April and September, with higher prevalence in adults
5015 than juveniles. The flies were more abundant in years when fall temperatures were high, winter
5016 precipitation levels were low, and summer temperatures were low, suggesting fly abundance is climate
5017 dependent. Consequently, the frequency of Hippoboscids flies in the Northern Spotted Owls population
5018 may vary in intensity as climate changes (Young et al. 1993).

5019 To address the shortfall of information on disease impacts to Spotted Owls, Recovery Action 17 of the
5020 2011 Recovery Plan is, "Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu,
5021 Plasmodium spp.) and address as necessary" (USFWS 2011a). In addition, the Department's Wildlife
5022 Investigation Lab is currently conducting a raptor disease and contaminant surveillance study that will
5023 help determine disease occurrence and contaminant exposure in raptor populations statewide,
5024 including both Northern and California Spotted Owls. This study will include targeted surveillance for a
5025 wide array of diseases and contaminants such as, WNV, mange, Avian Trichomonosis, Avian
5026 Chlamydiosis, and Avian Herpesvirus, AR and lead poisoning.

5027 Contaminants

5028 Northern Spotted Owls feed on a variety of prey species, but mainly small mammals make up a bulk of
5029 their diet (e.g., Forsman et al. 2004). Consequently, the main contaminant threat to the owls is
5030 anticoagulant rodenticide poisoning. The anticoagulant rodenticides (ARs) are grouped into first-
5031 generation compounds (diphacinone, chlorophacinone and warfarin), requiring several doses to target
5032 species before death occurs, and second-generation ARs (SGARs; e.g., bromadiolone, brodifacoum,
5033 difenacoum and difethalone), requiring only a single dose. Second generation ARs are more acutely toxic
5034 and persist in tissues and in the environment (Gabriel et al. 2013).

5035 Numerous field monitoring studies on other raptor and owl species indicate lethal and sublethal impacts
5036 of AR exposure (Mendenhall and Pank 1980, Stone et al. 2003, Walker et al. 2008, Albert et al. 2009,
5037 Murray 2011, Thomas et al. 2011, Christensen et al. 2012, Sánchez-Barbudo et al. 2012). In California,
5038 Lima and Salmon (2010) analyzed tissues from 96 raptors of 10 species brought to wildlife rehabilitation
5039 centers in San Diego and the Central Valley, and found that 69% (Central Valley) to 92% (San Diego) had
5040 been exposed to anticoagulant rodenticides. In Massachusetts, Murray (2011) tested 161 wild Red-

Comment [DK115]: I would suggest condensing this into just a couple of sentences, and include it with the paragraph above where you discuss "other diseases". Something like.... "A variety of blood and internal parasites have been documented in spotted owls including XXXXX in "subspecies" (citation), XXXX in "subspecies" (citation, etc....), but the effects of these parasites on owl fitness has not been reported"

Because ultimately, none of these things matter if they don't impact owl survival or reproduction.

Comment [DK116]: Yes, this is a good paragraph to wind up this section with – ultimately, we don't know much about disease in NSO, so it's a research need.

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5041 tailed Hawks, Barred Owls, Eastern Screech Owls (*Megascops asio*), and Great Horned Owls and found
5042 86 percent with ARs in liver tissue, of which 99 percent was brodifacoum, a SGAR. Another study in New
5043 York found ARs present in 49 percent of wild raptors tested (n=265; 12 species), most prevalent in Great
5044 Horned Owls (43/53; 81%) and less prevalent in Barred Owls (3/13; 23%), with SGARs (brodifacoum and
5045 bromadiolone) being the most frequently detected (Stone et al. 2003). Nine of the 53 Great Horned
5046 Owls and one of the 13 Barred Owls died in this study, revealing a mortality rate of 17 percent and 8
5047 percent, respectively (Stone et al. 2003).

Comment [DK117]: Again, too much detail – I'd suggest deleting. Just be sure citations are included in your 1st sentence – which essentially summarizes this detail.

5048 In addition to the field monitoring that demonstrates widespread exposure of raptor/owl species to ARs,
5049 investigations of wildlife mortality incidents show that raptors comprise two-thirds of the anticoagulant-
5050 related wildlife mortalities (Department's Wildlife Investigation Lab files). These incidents are most likely
5051 to be reported in more populated areas, but it is reasonable to assume that any area where ARs are
5052 used for outdoor rodent control would share a similar pattern. The Department's Wildlife Investigation
5053 Lab documented several recent cases of AR poisoning for the California Spotted Owl (K. Rogers, personal
5054 communication, September 25, 2014); two cases in 2013, and two in 2014. However, at this time it is
5055 unknown ~~how widespread whether~~ morbidity and mortality is widespread for the California Spotted
5056 Owl, or if poisoning is also occurring (and at what level) in Northern S ~~for the spotted owls population in~~
5057 California. As mentioned above, the Wildlife Investigation Lab is currently conducting a statewide raptor
5058 disease and contaminant surveillance study that will target AR occurrence in raptor populations to help
5059 shed light on the extent of this threat.

5060 ~~Few laboratory studies have been conducted that test impacts of ARs on raptors, and no known studies~~
5061 ~~have evaluated impacts on spotted owls. In a laboratory study by Mendenhall and Pank (1980), three~~
5062 ~~species of captive owls fed mice or rats killed with the ARs bromadiolone, brodifacoum, or diphacinone~~
5063 ~~(SGARs) died of hemorrhaging, those fed mice or rats killed with difenacoum (SGAR) displayed sublethal~~
5064 ~~hemorrhaging, and those fed mice or rats killed with fumarin or chlorophacinone (1st generation ARs)~~
5065 ~~displayed no signs of illness. Eastern Screech Owls were fed diphacinone for 7 days in a laboratory~~
5066 ~~setting and monitored for 21 days post exposure (Rattner et al. 2013). This study found that toxicity~~
5067 ~~appeared quickly upon exposure to lethal levels, but returned rapidly to normal in most owls after~~
5068 ~~exposure was terminated (Rattner et al. 2013).~~

5069 ~~Bond et al. (2013), notes T~~ the use of rodenticides (prevents damage to young trees from rodents
5070 browsing) or herbicides (suppresses shrubs to allow growth of trees) in burned forests might pose a and
5071 the potential threat of these substances to Spotted Owls through the ~~The use of herbicides and~~
5072 ~~rodenticides may reduction in e~~ the prey habitat and subsequently, abundance for Spotted Owls (Bond
5073 et al. 2013). ~~H~~ however it is unlikely the activity would be a major source of rodenticide exposure for
5074 owls because the type of poison used are generally 1st generation anticoagulants ~~rodenticides~~, which are
5075 not as persistent or toxic in their target species as other types of rodenticides (S. McMillin, personal
5076 communication, September 25, 2014).

5077 ~~In contrast, illegal marijuana grows are~~ are ~~widespread in the Northern Spotted Owl range and~~
5078 growers typically apply second generation AR at the base of plants to prevent small mammals from
5079 damaging the crop (Thompson et al. 2013, Gabriel et al 2013). These 2nd generation rodenticides present

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a risk to predators of small mammals, such as the Northern Spotted Owl, because this type of rodenticide is more acutely toxic, and persists in tissues and in the environment (Gabriel et al. 2013).

~~The fisher is a species whose range and prey base overlaps with the Northern Spotted Owl (Zielinski et al. 1999, Zielinski et al. 2004), thus, the impacts of rodenticides in fisher may also be an impact to Northern Spotted Owl. Thompson et al. (2013) studied impacts of ARs to fishers in the southern Sierra Nevada and found impacts of ARs in association with illegal marijuana grows significant. Toxicants found at grow sites within the southern Sierra Nevadas study area included brodifacoum and bromadiolone (SGARs), carbofuran (a pesticide currently banned in the United States), and malathion (an insecticide). Thirty nine out of 46 fisher carcasses recovered (88%) tested positive for one of more AR compound with brodifacoum being the most common (Thompson et al. 2013). Another fisher study in California's Sierra Nevada found 79 percent of fisher carcasses (n=58) tested were exposed to ARs, and of that, 96 percent were exposed to SGAR compounds (Gabriel et al. 2013). Given these results, and the presumed extent of illegal marijuana grows in California (Gabriel et al. 2013, Thompson et al. 2013), it is likely that exposure to AR prevalence is widespread and is impacting Northern Spotted Owls in California to some extent. However, the effects and prevalence of poisoning events on overall fitness (e.g., survival and fecundity) remains unknown.~~

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytophthora ramorum*) which infects a variety of species, ~~but it~~ is particularly lethal to tanoaks (*Lithocarpus densiflorus*) and several species of true oaks (*Quercus* spp.) ~~(citations?)~~. In other species it may cause dead bark, leaf blight, and twig dieback (Shaw 2007, USFWS 2011a), ~~or and some hosts may~~ be asymptomatic ~~(citations?)~~. Nearly all tree species in mixed evergreen and redwood-tanoak forest types may be hosts (Davidson et al. 2003, Garbelotto et al. 2003). According to Goheen et al. (2006),

“The pathogen has a wide host range including Douglas-fir, grand fir, coast redwood, and many other tree and shrub species common in Oregon and Washington forests. Tree mortality, branch and shoot dieback, and leaf spots result from infection depending on host species and location. *Phytophthora ramorum* spreads aurally by wind and wind-driven rain and moves within forest canopies and tree tops to stems and shrubs and from understory shrubs to overstory trees. The pathogen survives in infected plant material, litter, soil, and water. It is moved long distances in nursery stock... State and Federal personnel regularly survey forests and nurseries in the Pacific Northwest to detect the disease.”

In 1995, sudden oak death was discovered in California within Mill Valley (Marin County), and has since spread across multiple coastal counties impacting coastal live oaks and tanoak forests within (Tietje et al. 2005). According to recent submission to the GIS tool “OakMapper”, confirmed locations of *P. ramorum* in California range from the coastal ranges in Monterey County and north up through portions of Humboldt County (California Oak Mortality Task Force 2015). Many studies have documented the widespread damage and mortality of oak-tanoaks coastal woodlands from Humboldt to Monterey counties (Rizzo and Garbelotto 2003, McPherson et al. 2005, Goheen et al. 2006, Cobb et al. 2009, Cobb

Comment [A118]: Note to external reviewers: A publication is in the works to assess the potential impacts of ARs associated with marijuana plants to spotted owls, using barred owls as a surrogate. An abstract regarding this work, noted that the study found 40% of all Barred Owls tested were exposed to ARs in suitable NSO habitat within managed timberland in NW CA. The full analysis and result write-up are underway. Information from this effort will likely inform us on exposure to and impacts of ARs to owl fitness. This information will have to be added after external review, assuming it is ready prior to submission of this report to the Fish and Game Commission.

Comment [DK119]: Great! Assuming it's available that information would be better here than the Fisher info – which isn't particularly relevant except that it documents the widespread distribution of these ARs in the landscape – I think Gabriel et al. 2013 makes it pretty clear the stuff is toxic, so the real question is whether owls are picking the stuff up. Be careful with the BO numbers though too, because they eat such different things than the NSO – or rather it's possible that because the NSO focus more on arboreal mammals, and those small mammals are not as readily exposed to ARs, prevalence in NSO may be lower than BO in the same habitats. Although if NSO are eating “mostly” woodrats, then maybe BO are reasonably representative?

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et al. 2012). ~~Shaw (2007) indicated that t~~The disease in California is likely linked to coastal climates that are typically warmer and wetter than more inland forest types (Shaw 2007). There is large-scale concern regarding the impacts of this disease on forest structure and composition in California, and the associated impacts to wildlife species that inhabit these forests.

Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases quickly (Citations?). ~~Cobb et al. (2009) examined mortality caused by sudden oak death w~~Within coastal redwood forests from Sonoma to Monterey counties, ~~T~~tanoaks confirmed to be infected died on average within 1-6 years, and larger trees that were close to other infected species, such as the California bay laurel (*Umbellularia californica*), were infected to a greater extent than smaller, more remote trees (Cobb et al. 2009). Tanoaks survived longer within redwood and Douglas-fir dominated forests than in hardwood dominated stands (Cobb et al. 2009). ~~In Marin County, McPherson et al. (2010) examined the survival of coast live oaks, black oaks (Q. kelloggii) and tanoaks once infected by sudden oak death. In Marin County, California, once infected with sudden oak death, The study found that live oak and tanoak survival declined as a function of disease state (McPherson et al. 2010). Coast live oak survival was 11.7 to 15.8 years for asymptomatic trees; 7.5 to 11.7 years for trees that were only “bleeding” (only); and 2.6 to 3.4 years for trees bleeding with ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010). Tanoak survival was 8.8 years for asymptomatic trees; 5.9 years for trees bleeding only; and 1.7 years for trees bleeding with ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010).~~

Comment [DK120]: Explain what “bleeding” is here for us non-plant folks.

Comment [DK121]: So what happened to black oaks?

After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi and insects is common and impacts survival times (McPherson et al. 2005). For example, ~~McPherson et al. (2005) found~~symptomatic progression and eventual mortality of coast live oaks and black oaks due to sudden oak death followed a similar sequence: bleeding, beetle colonization, emergence of *Hyposylon thouarsianum* (another fungal infection), and then death (McPherson et al. 2005). Here, approximately 50% of bleeding live oaks were infected by ambrosia beetles and bark beetles, or showed evidence of past beetle infestation, whereas beetles infested tanoaks with less frequency (McPherson et al. 2005).

It is unlikely that the impact of sudden oak death on oak-tanoak forests will subside in the future. Brown and Allen-Diaz (2005) examined past, current and future changes of coast live oaks-bay laurel woodland structure and composition within the San Francisco Bay Area due to sudden oak death infections. There was a 2-27% loss of coast live oak basal area (m²/ha) during the study period (2002-2004), a 4-55% loss in the recent past (5-10 years prior to 2002) through 2004, and a projected 15-69% coast live oak basal area loss in the future, with a total stand basal area was predicted to decrease up to 42% within the next 5 years (Brown and Allen-Diaz 2005). Meentemeyer et al. (2009) predicted that with no control measures, sudden oak death will increase by 10-fold by 2030, particularly along the coast north of San Francisco. The model suggests that wet weather conditions exacerbated by predicted change climate regimes serve to double the rate of spread in California (Meentemeyer et al. 2009). Predictive models note forests at high risk to sudden oak death in California occur in coastal forests of Santa Barbara County north through Humboldt County (Koch and Smith 2012).

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Oak-tanoak forests are present within the Northern Spotted Owl range in California and are an important component to owl habitat (see Habitat Section of this report). Oak and tanoak forest types and as elements within conifer forest provide habitat for the owl's main prey base, the dusky-footed woodrat, as well as other small mammals that comprise a smaller component of the owl's diet. There are no known published work evaluating the wildlife consequences of sudden oak death focus on impacts to Northern Spotted Owl habitat; however, results from these studies may inform potential or likely impacts of sudden oak death the species given what we know about owl habitat and prey needs.

Within an infected study site in on Marin County, Temple and Tietje (2005) found coarse woody debris, a habitat component important for many small mammals, was 70 times higher than on an uninfected plot in Sonoma County, a difference supposedly due to sudden oak death-induced coarse woody debris generation. Within San Luis Obispo County, an area where sudden oak death has a low prevalence, areas in "high-risk" woodlands (i.e., those with species composition thought to be most impacted by sudden oak death) small mammals, including the dusky-footed woodrat, were more abundant (Temple et al. 2005, Temple and Tietje 2005). The difference in species abundance between the sites is likely inherent, ~~the authors' link to so the link to~~ sudden oak death impacts ~~in this of the~~ comparison is unclear. However, these studies speculate that California bay laurel may replace coast live oak trees in the forest canopy. While having ecological importance, California bay laurel is relatively less productive than oaks as a wildlife habitat component.

Only one study has provided any direct link to Spotted Owl occupancy and habitat impacts due to sudden oak death. Within Big Sur forests of California, Holland et al. (2009) indicated that California Spotted Owl were more likely to occur in forests with greater amount of tree mortality, suggesting sudden oak death could benefit owls in the short-term by generating coarse woody debris (e.g., downed logs and branches), key habitat features for the owl's prey resources. However, over the long-term, coarse woody debris and snags will decay and the supply will diminish thus prey resources may decrease and thereby impacting habitat suitability for the owls.

More generally, several studies indicate an impact on small mammal populations associated with sudden oak death infestations within coastal forests, but do not provide a link between Spotted Owl occupancy. Several studies suggested that that woodrats and mice (*Peromyscus* spp.) may benefit from immediate changes in habitat features (e.g., increase in coarse woody debris, increased shrub cover) within infected areas; however long-term abundance is less certain in the face of continued sudden oak death infection (Apigian et al. 2005, Temple and Tietje 2005).

The 2011 Northern Spotted Owl Recovery Plan (USFWS 2011a) notes this disease as a potential threat "due to its potential impact on forest dynamics and alteration of key prey and Spotted Owl habitat components (e.g., hardwood trees, canopy closure, and nest tree mortality)... especially in the southern portion of the Spotted Owl's range (Courtney et al. 2004)." However, the USFWS (2011a) asserted that the extent of the impact of sudden oak death to owl habitat, prey species, and occupancy has not been thoroughly assessed. To address the shortfall of information, Recovery Action 17 of the 2011 Recovery Plan is to "Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, *Plasmodium* spp.) and address as necessary" (USFWS 2011a). Monitoring techniques have been developed and may consist of

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5196 regular aerial and ground surveys to assess rate of sudden oak death infection within oak-tanoak forest
5197 communities (Mai et al. 2005). However, such monitoring will detect spread well after a local invasion is
5198 established. Early detection techniques, such as eDNA sampling, may allow quicker intervention, but the
5199 efficacy of the various methods (Cobb et al 2013) still needs thorough evaluation.

5200 **Predation**

5201 The 2011 Revised Recovery Plan (USFWS 2011a) states,

5202 “Known predators of Spotted Owls are limited to great horned owls (Forsman et al. 1984), and,
5203 possibly, barred owls (Leskiw and Gutiérrez 1998). Other suspected predators include northern
5204 goshawks, red-tailed hawks, and other raptors (Courtney et al.2004). Occasional predation of
5205 Spotted Owls by these raptors is not considered to be a threat to Spotted Owl populations, so
5206 no criteria or actions are identified.”

5207 No new information has been generated since this statement was made, and therefore, the threat of
5208 predation to Northern Spotted Owls remains negligible.

5209 **Recreational Activities**

5210 Natural stress events (predator interactions, precipitous weather, disease, care of young), or
5211 anthropogenic stress events (vehicle traffic and noise, hikers) can impact species on multiple levels. This
5212 may include physiological impacts such as suppressed reproduction and growth (REFS), or behavioral
5213 responses such as avoidance (e.g., vocalizations and flushing).

5214 Collecting and analyzing fecal samples has been shown to be effective at detecting stress hormone
5215 production (e.g., glucocorticoids) in owls (Wasser and Hunt 2005). By employing this methodology, a
5216 study conducted in the Shasta Trinity and Mendocino National Forests, California, found Northern
5217 Spotted Owls exhibit more stress when exposed to motorcycle activities, and exhibit lower reproductive
5218 success when exposed to busy roads (Hayward et al. 2014). Wasser et al. (1997) collected fecal samples
5219 from wild Northern Spotted Owl in Washington to measures stress hormone production in relation to
5220 timber activities (e.g., logging roads timber management). Males showed a more prominent increase in
5221 corticosterone production when the disturbance occurred with 0.41 km (0.25 miles) of the home range
5222 center, and in males whose home ranges were close to clear-cut (vs. selective logging).

5223 Presence of hikers has been shown to alter owl behavior at roosting and nesting sites. Stwarthout and
5224 Steidl (2001) found that juvenile and adult Mexican Spotted Owls were less likely to flush from the
5225 presence of a hiker at 212 and 224 meters, respectively, and neither juveniles nor adults were likely to
5226 alter behavior at distances 255 meter or more. At nesting territories, Mexican Spotted Owls in Utah
5227 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance
5228 with the presence of hikers (Swarthout and Steidl 2003).

5229 It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the
5230 level to which these activities may impact owl behavior, reproduction and overall survival has yet to be

Comment [DK122]: Yeah, but there was no link between increased cort levels and fitness consequences (repor and/or survival), so we can't know what this means.

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5231 determined. It is unlikely anthropogenic stress events associated with recreation will impact Northern
5232 Spotted Owl reproduction and survival to any great extent, though further research is warranted.

5233 **Loss of Genetic Variation**

5234 There had previously been little evidence in the literature of loss of genetic variation and population
5235 bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across
5236 the range of the Northern Spotted Owl provides compelling evidence that a population bottleneck may
5237 have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from
5238 352 Northern Spotted Owls from six regions across the range which included limited samples from the
5239 northern portion of the California Klamath Province.

5240 Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades)
5241 bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant
5242 evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest
5243 California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic
5244 variation and hence effective population size, do not necessarily indicate a decline in actual
5245 (demographic) population size (Funk et al. 2010) "... it is important to keep in mind that
5246 reductions in [effective population size] (detected with bottleneck tests) are different than
5247 reductions in demographic population size (detected with demographic field studies) and
5248 reductions in one of these parameters does not necessarily result in a change in the other."
5249 (Funk et al. 2010)

5250 The scientific review of the Draft Recovery Plan Recovery was able to review unpublished genetic
5251 studies from Dr. Susan Haig (Courtney et al. 2008). Using samples collected from 352 owls, the results
5252 provided some evidence that recent bottlenecks have occurred at various spatial scales within the
5253 Northern Spotted Owl range, but could not definitively link the genetic declines to recent population
5254 declines (USFWS 2011a, Courtney et al. 2008). Genetic scientists reviewing Haig's work concluded that
5255 the bottlenecks observed by Haig were likely the result of recent population declines rather than the
5256 cause of decline (Courtney et al. 2008). Specifically, Courtney et al. (2008) states,

5257 "The conclusion by Barrowclough and Coats (1985) is still appropriate here, which is that the
5258 population dynamics of the Spotted Owl likely will be more important to its short-term survival
5259 than will be its genetic makeup, regardless of the evidence for bottlenecks having occurred in
5260 the past. Our conclusions might warrant re-consideration at some future point, in the context of
5261 explicit evidence linking reductions in genetic diversity to current conditions, and current or
5262 future population performance. "

5263 **Summary of Listing Factors**

5264
5265 The California Endangered Species Act directs the Department to prepare this report regarding the
5266 status of the Northern Spotted Owl in California based upon the best scientific and other information
5267 available to the Department (Fish & G. Code, § 2074.6, subd. (a); Cal. Code Regs., tit. 14, § 670.1, subd.

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5268 (f)). CESA’s implementing regulations identify key factors that are relevant to the Department’s analyses.
5269 Specifically, a “species shall be listed as endangered or threatened ... if the Commission determines that
5270 its continued existence is in serious danger or is threatened by any one or any combination of the
5271 following factors: (1) present or threatened modification or destruction of its habitat; (2)
5272 overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-
5273 related activities.” (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

5274 The definitions of endangered and threatened species in the Fish and Game Code guide the
5275 Department’s scientific determination. An endangered species under CESA is one “which is in serious
5276 danger of becoming extinct throughout all, or a significant portion, of its range due to one or more
5277 causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or
5278 disease.” (Fish & G. Code, § 2062). A threatened species under CESA is one “that, although not presently
5279 threatened with extinction, is likely to become an endangered species in the foreseeable future in the
5280 absence of special protection and management efforts required by [CESA].” (*Id.*, § 2067).

5281 The Department’s summary of listing factors are summarized below:

5282 **Present or threatened modification or destruction of habitat**

5283 *Timber Harvest and Regulatory Considerations*

5284 Although the rate of nesting and roosting habitat loss has declined since the Northern Spotted Owl was
5285 listed under the federal endangered species act in 1990, assessments performed ~~on~~ range-wide since the
5286 implementation of the NWFP show that habitat loss on federal and private lands is ongoing. Wildfire
5287 and other natural disturbance has been the leading cause of habitat loss on federal land, whereas and
5288 timber harvest has been the leading cause of habitat loss on nonfederal lands since 1994. Although state
5289 regulations governing timber harvest on nonfederal lands in California (i.e., California Forest Practice
5290 Rules) are the most protective state regulations in the range of the Northern Spotted Owl, losses of
5291 nesting and roosting habitat due to timber harvest in California have continued. Since 1994, 5.8% of
5292 nesting and roosting habitat on nonfederal lands in California has been removed by timber harvest.

5293 California Forest Practice Rules

5294 Minimum habitat retention requirements are identified in the Forest Practice Rules for timber harvest
5295 occurring on privately owned land in California. Definitions for the different habitat types to be retained
5296 are also included in Forest Practice Rules. Habitat Retention requirements and definitions were
5297 developed in the early 1990s and can be found in Table 20 and Appendix 2. Retention requirements
5298 were established for a combination of nesting, roosting, and foraging habitat in the area immediately
5299 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the
5300 broader home range (1.3 mile radius).

5301 The most recent research on Northern Spotted Owl habitat requirements in California and southern
5302 Oregon have demonstrated a link between owl fitness and the amount of different habitat types, ~~of~~
5303 ~~habitat~~, structural characteristics of habitat, and the spatial configuration of habitat types in owl a-home

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5304 | ranges. This requirement for habitat heterogeneity is consistent with the general approach incorporated
5305 in the Forest Practice Rules. Although study design has varied across the major research studies, some
5306 consistent patterns have arisen. In order to support productive Spotted Owl territories, a minimum
5307 amount of older forest must be retained in the core area. The definition of 'older forest' evaluated in
5308 studies has varied, but consistently includes late-seral forests with large trees and high canopy cover.
5309 Productive territories generally had at least 25-40% older forest in an approximately 400 acre core area.

5310 Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling
5311 cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness.
5312 Results indicate that in order to support a productive Northern Spotted Owl territory, no more than
5313 about 50% of a home range should consist of nonhabitat.

5314 The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations
5315 for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest
5316 Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls. The total acreage of
5317 recommended retention in the USFWS guidance does not differ from that found in the Forest Practice
5318 Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range
5319 must be retained in habitat. However, based on assessment of core use areas in the interior portion of
5320 the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an
5321 activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations
5322 in line with core use areas evaluated in recent work. The most significant change in the revised USFWS
5323 recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific
5324 amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for
5325 nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained
5326 near the core is consistent with the literature.

5327 A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised
5328 USFWS recommendations (see Table 22 for the interior portion of range in California) shows large
5329 discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under
5330 the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the
5331 USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
5332 This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500
5333 acres of spotted owl habitat that must be retained within 0.7 miles and the total of 1,336 acres that
5334 must be retained within 1.3 miles of an activity center can be composed of "functional foraging
5335 habitat" under Forest Practice Rules, a definition that is considered low quality foraging habitat by the
5336 USFWS. T; therefore, there is no requirement under in the Forest Practice Rules for habitat beyond 500
5337 feet of a nest tree to this habitat include nesting or roosting habitat under the Forest Practice Rules.

5338 Our assessment of selected activity centers shows that even the current habitat retention guidance in
5339 the Forest Practice Rules are not always met, indicating that harvest is impacting individual Northern
5340 Spotted Owls at some locations on some private lands. Of the activity centers evaluated, several
5341 experienced very high acreages of harvest at both the broad home range and at in the core area scale,
5342 which would have resulting ed in territories that do not meet the USFWS recommendation for take

Comment [DK123]: I agree - see comment far above about this.

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5343 avoidance, and which could have resulted in negative consequences on ~~would have resulted in declines~~
5344 in survival and fitness of ~~the~~ local owls.

Comment [DK124]: So did you actually evaluate owl survival, etc., on these activity centers? The tenses used in this sentence are confusing – difficult to tell what was documented vs. what was predicted.

5345 Documentation of habitat type, amount, and distribution present around activity centers after THPs are
5346 implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the
5347 Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if
5348 minimum retention requirements in the Forest Practice Rules are implemented as written, there is still
5349 the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated
5350 failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts
5351 that have occurred in recent years.

5352 The THP review and post-harvest follow-up process should ensure that the best scientific information is
5353 being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to
5354 which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a
5355 sample of activity centers indicates that it is not universally applied and that insufficient habitat has
5356 been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern
5357 Spotted Owl is likely to continue experiencing loss of habitat in California.

5358 Salvage Logging

5359 Several variables complicate the interpretation of owl response to fire, including variation in fire
5360 severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing
5361 and duration of research post-fire. Regardless, several studies have suggested that salvage logging after
5362 a fire or occurrence of extensive high severity burns likely have contributed to a decline in habitat use,
5363 occupancy, or survival of Northern Spotted Owls. Although hampered by small sample size, incidental
5364 observations have documented declines in occupancy of burned areas following salvage logging.
5365 Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction
5366 probabilities, although the impacts of salvage logging were observed only in combination with other
5367 factors.

5368 The presence of snags has been suggested as an important component of prey habitat and as perch sites
5369 for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub
5370 and herbaceous cover and number of snags, may be impacted by salvage logging.

5371 Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the
5372 fire itself, by removing important structural elements and removing important prey habitat. The
5373 available information suggests that salvage logging reduces the probability that spotted owls will use
5374 burned areas and has resulted in declines in occupancy, either through abandonment or declines in
5375 survival.

5376 *Wildfire*

5377 Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and
5378 wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994,

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5379 after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to
5380 wildfire, and most of this loss has occurred in the Klamath Province.

Comment [DK125]: See Davis et al. 2015 – I think this is now over 5% -

5381 The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to
5382 use burned areas extensively, although nesting and roosting general occurred only in unburned or low-
5383 severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by
5384 California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in
5385 burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some
5386 evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

5387 Conversely, occupancy rates for Northern Spotted Owls in southern Oregon were shown to have
5388 declines declined in occupancy following fire. These declines resulted from both high extinction rates in
5389 burned areas and low colonization rates.

5390 Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to
5391 experience declines in survival. Food limitation in burned areas may have been a factor in declining
5392 survival rates. These observed declines in southern Oregon may be confounded by the occurrence of
5393 post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl
5394 subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in
5395 the year following fire; these owls were not tracked to investigate potential longer-term effects.

5396 Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or
5397 areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance
5398 for foraging.

5399 The available information suggests that wildfires can have positive effects on Northern Spotted Owls
5400 when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without
5401 removing important nesting and roosting habitat components at the territory scale. However,
5402 uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating
5403 required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed
5404 in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be
5405 used as a management tool.

5406 Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California
5407 included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades,
5408 fires have become more frequent and average fire size has increased. In some cases fires have also
5409 burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry
5410 and hot conditions). Because climate change will likely increase the likelihood of conditions that support
5411 fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

5412 Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue
5413 experiencing loss of habitat in California.

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5414 *Climate Change Impacts to Forest Composition and Structure*

5415 Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate
5416 projection scenarios specific to California, the most notable response to increase temperature was a
5417 shift from conifer-dominated forests (eg., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g.,
5418 Douglas fir-tan oak) in the northern half of the state, expansion of conifer forests into the northeast
5419 portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine
5420 forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-
5421 tan oak forests, and advancement of conifer-dominated forests (e.g., redwood and closed-cone pine
5422 forests) along the north-central coast. Tree productivity along California's north-central coastal and at
5423 high elevation forests may increase in response to increased growing season temperatures; however,
5424 reductions in summer fog in concert with increased temperatures may reduce productivity of redwood
5425 forests along the coast. In addition, the literature suggests that climate change variables will increase
5426 the severity and frequency of wildfires within the Northern Spotted Owl range.

5427 Although climate projection models have uncertainties built-in, it is apparent from the literature that
5428 forests within California will likely experience some level of elevational and latitudinal shifts, changes in
5429 species composition, and alterations in fire regimes. For the Northern Spotted Owl, who has a heavy
5430 reliance on specific forest structure components and tree species composition, and associated prey
5431 habitat and abundance, implications of such forest shifts and fire regime changes may prove
5432 unfavorable to the species over time. During long-term landscape planning related to Northern Spotted
5433 Owls and their habitat, potential climate change impacts should be analyzed and incorporated.

5434 *Other Mechanisms of Habitat Loss*

5435 Sudden Oak Death

5436 Sudden oak death syndrome is recognized as a potential threat to Northern Spotted Owls due to
5437 impacts on forest structure and composition, and consequently alteration of prey habitat and
5438 abundance. The disease is particularly lethal to tanoaks and several species of true oaks. Confirmed
5439 locations of sudden oak death in California range from the coastal ranges in Monterey County and north
5440 up through portions of Humboldt County. Portions of California coastal forests at a high risk of infection
5441 have been identified in Santa Barbara County north through Humboldt County.

5442 Predictive modeling studies indicate that the disease is projected to increase 10-fold by 2030 in
5443 California, which could be exacerbated by wetter weather conditions on the coast predicted by climate
5444 change models. Given this, there is concern over the potential impact of sudden oak death in California
5445 to Northern Spotted Owls in the future. For instance, oak-tanoak forests support the dusky-footed
5446 woodrat, one of the owl's main prey species, as well as other small mammals that comprise a smaller
5447 component of the diet. If abundance of prey is altered within the range of the Northern Spotted Owl
5448 due to decreases in oak-tanoak forests, negative impacts to owls will likely ensue.

5449 Though no studies have yet evaluated the consequences of sudden oak death specific to Northern
5450 Spotted Owl habitat and fitness in California, there is evidence that habitat and prey abundance will be

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5451 impacted in the face of this disease, and impacts will vary spatially and temporally. The literature
5452 suggests that short-term impacts may initially provide an increase in prey habitat and abundance, and
5453 thus may lead to an increased owl occupancy rate. However, this phenomenon will likely subside when
5454 habitat conditions deteriorate over time or tree species composition changes to a point the area can no
5455 longer support key owl prey species.

5456 The extent of sudden oak death impacts to Northern Spotted Owl habitat, prey species, and occupancy
5457 needs to be thoroughly assessed. Early detection techniques should be explored and implemented
5458 within coastal California forests so that negative impacts can be realized and remediated, if possible.

5459 Marijuana Cultivation

5460 Illegal and legal marijuana cultivation in remote forests on public and private land throughout California
5461 has been steadily increasing. on a steady increase. Within the range of the Northern Spotted Owl,
5462 Shasta, Tehama, Humboldt, Mendocino, and Trinity counties comprise the areas known for the most
5463 marijuana cultivation in California due to the remote and rugged nature of the land (making cultivation
5464 difficult to detect), and habitat conditions favorable for growing marijuana (e.g., wetter climate, rich
5465 soils). Given the difficulties in detecting both illegal marijuana cultivation sites and the lack of reporting
5466 of legal cultivation sites, actual distribution and density of marijuana cultivation is likely larger and
5467 higher than current data suggests represented in datasets collected to date.

5468 Activities associated with cultivation (e.g., removal of large trees, degradation of riparian habitat, use of
5469 rodenticides) may negatively impact Northern Spotted Owl habitat, although there is little data on the
5470 extent of this impact is not well known. Areas with higher prevalence of marijuana cultivation may also
5471 contain high numbers of Northern Spotted Owl activity centers. The level of impact likely depends on
5472 several factors, including the density of cultivation sites in proximity to owl activity centers and how
5473 much owl habitat is affected and to what extent. Given that marijuana cultivation is on the rise in
5474 California, a thorough assessment of potential habitat impacts to Northern Spotted Owls should be
5475 implemented.

5476 **Abundance and Demographic Rates**

5477 Few studies have attempted to examine range-wide Northern Spotted Owl population estimates. Survey
5478 methodology and effort does not allow for is reliable estimates across the range or within California, and
5479 does not effectively sample nonterritorial floater individuals. Northern Spotted Owl densities vary
5480 across the range and forest types; therefore, extrapolating the few local estimates across the range of
5481 the subspecies would result in biased estimates of abundance. The Department's Spotted Owl Database
5482 houses a cumulative tally of all historic owl observations and activity centers, and for this reason it is
5483 inappropriate to use the Dataset as a surrogate for abundance and density estimates. The increase in
5484 number of activity centers over time is more likely the result of expanded survey effort than
5485 establishment of new activity centers. In addition, across most of the Northern Spotted Owl range
5486 establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a
5487 slow process given tree species growth rate (with a possible exception on the coastal redwood forests),
5488 and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

Comment [DK126]: What has increased? Total acreage under cultivation or number of growers or both?

Comment [DK127]: How is this "known"? Law enforcement data?

Comment [DK128]: ?? Where does this information come from?

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5489 One recent study made use of the immense amount of data available on Northern Spotted Owl habitat
5490 requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity,
5491 dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the
5492 range of the owl. In addition to an evaluation of source-sink dynamics, outcomes of the model included
5493 a range-wide population size estimate, and the proportion of the population in each modeling region
5494 and physiographic province noted in the 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The
5495 study estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner
5496 California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling
5497 regions. Three provinces located in California were estimated to contain over 50 percent of the range-
5498 wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a
5499 stronghold for the population. Even though the complexity of the model may limit its ability to
5500 accurately model population estimates, the results suggest that California's population of Northern
5501 Spotted Owls is an important component of the range-wide population.

5502 Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource
5503 Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for
5504 more than two decades to assess demographic parameters such as population growth, survival,
5505 fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study
5506 areas range-wide. In California, the most recent meta-analysis covering years 1985-2008 reported a
5507 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline
5508 per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the
5509 Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation
5510 study area reported a 2.3% population decline per year through 2012. When converting estimates for
5511 population change to estimates of realized population change (i.e., the proportional change in estimated
5512 population size relative to population size in the initial year of analysis) two study areas in California
5513 (Green Diamond Resource Company and Northwest California) showed estimated population declines of
5514 about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight
5515 decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary
5516 meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across
5517 the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The
5518 ongoing analysis has revealed declines in California between 32 and 55% over the study period.

Comment [DK129]: Revise following Dugger et al. in press.

5519 In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young
5520 produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged
5521 from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green
5522 Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian
5523 Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in
5524 Washington and Oregon. Although less severe than in Washington and much of Oregon, all three
5525 California study areas show declines in survival.

5526 Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in
5527 California give us information on current estimates for reproductive success (number of young fledged

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5528 per monitored site) and survival, and are consistent with a continued decline within all demographic
5529 study areas in California. In the coastal portion of the Northern Spotted Owl range in California, many
5530 areas reported consistently low reproductive success from 2011-2013, including some of the lowest
5531 reproductive success rates on record in 2013 despite weather conditions that would typically support
5532 good reproductive success. This was observed on many timber company lands, tribal lands, and National
5533 Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In
5534 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive
5535 rate since 2009.

Comment [DK130]: Same factors remain in play today – meta-analysis reflect conditions on federal lands (high confidence of that), less confident that 3 non-fed areas representing all non-fed lands – probably better off than most non-fed lands.

5536 The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study
5537 areas in California reflected trends on non-federal lands because two study areas are on non-federal
5538 lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl
5539 habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal
5540 land. However, the authors also suggest that results depict an optimistic view of the overall population
5541 status of the Northern Spotted Owl on private lands because the non-federal lands included in the
5542 demographic study areas are managed for owls. Results from the demographic study areas are thought
5543 to be representative of federal lands and areas of mixed federal and private lands throughout the range
5544 of the Northern Spotted Owl because the study areas were large, distributed across a broad geographic
5545 region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

5546 Occupancy data is based on the presence or absence of owls from known sites. In order for estimates of
5547 occupancy to be valid, survey efforts must be consistent over time and the detection probability (the
5548 probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead
5549 to high variation in detection probability which can skew estimates of occupancy if not accounted for.
5550 Although an evaluation of occupancy rates has not been included in previous demographic meta-
5551 analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the
5552 number of territorial owls detected on all 11 areas was lower at the end of the study period than at the
5553 beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling
5554 for the first time. Preliminary results show that occupancy rates have declined at all three California
5555 study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on
5556 occupancy by increasing the local territory extinction rate.

Comment [DK131]: Substantially lower!!

5557 Occupancy has been shown to be in decline for areas outside the California demographic study areas as
5558 well. For example, the southern Cascades and interior Klamath provinces of California determined
5559 occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl
5560 declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

5561 It is clear that the declining Northern Spotted Owl population declines have not stabilized, and
5562 estimates of demographic rates across the range indicate the declines in demographic parameters,
5563 including population size, have in fact accelerated since the meta-analysis conducted through 2009. The
5564 level of decline does not seem to be slowing even with the implementation of the Northwest Forest Plan
5565 and the California Forest Practice rules. A careful look at threats leading to these declines is warranted,

Comment [DK132]: Well it was, until this latest meta-analysis. See Discussion of Dugger et al. (in press) and summary table showing how annual rate of decline slowed through 2009, but has increased in last 5 years.

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5566 including revaluation of the effectiveness or management techniques across the Northern Spotted Owl
5567 range in California.

5568 Predation

5569 Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-
5570 tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The
5571 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted
5572 Owls is not a threat to the population. In the case of documented Barred Owl aggression toward
5573 Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented
5574 mortalities were due to territorial aggression. Given that predation is not considered to be a major
5575 threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly
5576 manage predation issues.

5577 Competition

5578 Over the last several decades, Barred Owls have gradually moved further into the range of the Northern
5579 Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been
5580 present the longest (British Columbia and Washington), with fewer detections made in the southern
5581 edge of the range (California) where they have been present for a shorter duration. Currently, Barred
5582 Owls have been documented in all portions of the Northern Spotted Owl range throughout California,
5583 though densities of Barred Owls are unknown.

5584 Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to
5585 the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most
5586 important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat
5587 and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong
5588 indication that the two species can coexist over time, sharing the same habitat and prey-base, because
5589 there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and
5590 not by Barred Owls.

5591 Public workshops held by the USFWS have resulted in four published and one unpublished meta-
5592 analyses since 1994 to assess population parameters, such as abundance, trend, and survival. These
5593 analyses show that in areas where Barred Owls are present, the decline in Northern Spotted Owl
5594 abundance has been steeper than where the Barred Owl was absent. Declines have been more
5595 prevalent where Barred Owls density was greatest. Northern Spotted Owl adult survival has declined in
5596 a majority of the range where Barred Owls were present, with a more gradual decline noted in California
5597 largely attributed to the relatively more recent Barred Owl expansion into this portion of the range.
5598 Presence of Barred Owls in or near Northern Spotted Owl territories is also thought to negatively
5599 impacts fecundity, survival, and occupancy dynamics of Northern Spotted Owls.

5600 Experimental studies to remove Barred Owls conducted in California demonstrated that Northern
5601 Spotted Owl occupancy decreased with Barred Owl presence and increased with Barred Owl removal,

Comment [DK133]: This is changing quickly! See Appendix C in Dugger et al. in press. Data and discussions with crew leaders on areas in CA monitoring NSO demographics suggest BO have increased dramatically in last 5 years – this is pretty consistent with “invasion dynamics” where some threshold is reached and the invading population just takes off.

Comment [DK134]: See previous comments about this. Not “public” workshops and not held by USFWS.

Comment [DK135]: This is not exactly what has been depicted. BO presence/absence has been linked to rates of decline via survival and recruitment, but effects on lambda directly have not been modeled. Of course declines are worse in the north (i.e., lambda lowest in WA).....where BO have been present at higher densities the longest.

Comment [DK136]: We’ve never really know “density” – although that’s changing as we conduct area-wide surveys for BO in conjunction with the BO removal experiment on 4 study areas.

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5602 suggesting that Barred Owls are displacing Northern Spotted Owls from their territories, forcing them
5603 into lower quality breeding and foraging habitat.

Comment [DK137]: Actually, we don't know where they're going – they may be dying, they may be surviving nearby, they may be moving greater distances to find new habitat. We don't have any information on where they are going, so we can't really say anything about the kind of habitat these "displaced" NSO are using.

5604 Given the severity of impacts and the quick range expansion into California, Barred Owl is considered
5605 one of the major threats to Northern Spotted Owl populations in California. More research is needed to
5606 assess Northern Spotted Owl site occupancy, reproduction, and survival in the face of Barred Owl
5607 presence, including the implementation of experimental removal of Barred Owls. Resource partitioning
5608 between the two species also needs further investigations.

5609 **Disease**

5610 Several studies indicate that raptors, including Spotted Owls, may be impacted at some level by disease
5611 and insect infestations (e.g., West Nile Virus, avian influenza, avian malaria, Leucocytozoonosis, fly/mite
5612 infestations). The 2011 Northern Spotted Owl Revised Recovery Plan recognizes that disease threat is
5613 unknown, but may significantly impact owls. Disease occurrence in Northern Spotted Owls is likely
5614 under-reported because owls tend to inhabit remote areas and, therefore, there is a small likelihood of
5615 carcass recovery for testing. Disease may be a significant threat to Northern Spotted Owls, but more
5616 research is needed to better understand prevalence and magnitude of impacts in owl populations in
5617 California.

5618 **Other Natural Events or Human-related Activities**

5619 *Precipitation and Temperature Changes*

5620 Most climate projection scenarios agree that the forests in the Northern Spotted Owl's range will have
5621 wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased
5622 frequency and intensity of disturbance events. According to many climate projections, the frequency
5623 and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will
5624 increase over time. Vulnerability to disturbance, such as wildfire, disease, and insect outbreaks, is
5625 expected to increase in most forests in the Northwest and may change forest composition and structure
5626 depending on changes to climate. Climate modeling studies agree that forest wildfire occurrence and
5627 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced
5628 snowpack, earlier spring snowmelts, and longer drier summers.

5629 Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These
5630 studies indicate that winter precipitation is closely associated with a decrease in survival and
5631 recruitment; population growth was positively associated with wetter conditions during the growing
5632 season (May through October) and negatively associated with cold/wet winters and nesting seasons,
5633 and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction
5634 increased with late nesting season precipitation and decreased with warm temperatures; and owls may
5635 be more sensitive to changes in spring time climatic events.

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It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many climate projections forecasting steady changes in the future. Climate change studies predict future conditions that may negatively impact owls, such as wet and cold springs, more frequent and severe summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased frequency of severe wildfire events. Yet in some instances projected future conditions, such as increased frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other areas of the range. Looking at past precipitation and temperature trends, drying trends across most of the range coupled with warmer winters and cooler summers in the interior and cooler winters and warmer summers along the coast may play a role in both owl and prey population dynamics. More research is needed to assess the extent of these climate impacts on survival, population growth, and reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of climate change outweigh the positive ones.

Climate change will likely impact the Northern Spotted Owl in California, but the degree to which it is a threat to the species continued existence in the short- or long -term needs further investigation. During long-term landscape planning related to Northern Spotted Owls and their habitat, potential climate change impacts should be analyzed and incorporated.

Recreational Activity

Relatively few studies have been conducted on the impact of recreational activity on Northern Spotted Owls. A few studies suggest that stress levels increase in individual Northern Spotted Owls when exposed to motorcycle activities, timber harvest activities, and presence of hikers. It is clear recreational activities impact Northern Spotted Owls to some extent, but the level to which these activities may impact owls has yet to be determined. It is unlikely anthropogenic stress events associated with recreation will impact Northern Spotted Owl reproduction and survival to any great extent, though further research is warranted.

Loss of Genetic Variation

Loss of genetic variation is not considered to be a major threat to Northern Spotted Owls at this time. Some recent studies provide evidence that a population bottleneck may have occurred within the last few decades across the range of the Northern Spotted Owl; though no effect was documented for Northwest California.

Management Recommendations

The goal of the Department is to secure recovery and long-term survival of the Northern Spotted Owl across their historic range. The Department has evaluated existing management measures and has identified the following management recommendations, listed in no particular order, as necessary to

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5672 help achieve the aforementioned goal. Many of these recommendations are adapted from the USFWS
5673 Northern Spotted Owl Recovery Plan (USFWS 2011a) and are based on the best available scientific
5674 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where
5675 applicable. As new information becomes available, recommendations may be further refined.

5676 Planning and Timber Practices

- 5677 1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is
5678 consistent with the recovery of the species (see RA14).
- 5679 2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-
5680 range planning, setting priorities for scientific research and investigations, and/or when making
5681 major decisions affecting the Northern Spotted Owl (see RA5).
- 5682 3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative
5683 opportunities for nonfederal landowners to engage in management strategies (see RA15).
- 5684 4. Consider long-term maintenance of local forest management infrastructure as a priority in
5685 planning and land management decisions (see RA16).
- 5686 5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and
5687 contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of
5688 Northern Spotted Owls (see RA21).
- 5689 6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential
5690 recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in
5691 California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration,
5692 HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
- 5693 7. Improve ~~thorough~~ documentation of harvest prescription methods within timber harvest plans
5694 (i.e., increase amount and detail of information), and ~~conduct a~~ rigorous evaluations of post-
5695 harvest levels of foraging, nesting, and roosting habitat.
- 5696 8. Evaluate the effects of silvicultural practices on important Spotted owl prey species (e.g., flying
5697 squirrel, woodrat) and their required habitat.

5698 Population Trend and Demographic Parameters

- 5699 9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if
5700 the California population is decreasing, stationary or increasing (see RA2).
- 5701 10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy
5702 across its California range (see RA3).

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- 5703 11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival,
5704 population growth and reproductive rates of Northern Spotted Owls in California, and
5705 determine if negative impacts of climate change outweigh the positive ones.
- 5706 Habitat
- 5707 12. Manage Northern Spotted Owl habitat in a way that accelerates the development of structural
5708 complexity and biological diversity that benefits Spotted Owl (see RA6)
- 5709 13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl
5710 habitat) while allowing for other threats, such as wildfire and insects, to be addressed by
5711 restoration management actions (see RA32).
- 5712 14. Conserve Northern Spotted Owl sites and high value habitat to provide additional demographic
5713 support to population dynamics (see RA10).
- 5714 15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to
5715 inform decisions concerning the possible development of habitat conservation networks in
5716 California (see RA4).
- 5717 16. Assess habitat requirements for, and barriers to, dispersal in California through research on
5718 Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and
5719 availability, and habitat modeling.
- 5720 17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath
5721 Province) to assist evaluating landscape-level issues in the Provinces in California, including
5722 monitoring and adaptive management actions (see RA7 and RA9).
- 5723 Wildfire
- 5724 18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).
- 5725 19. Retain large, dense patches of forests embedded in a matrix with reduced stand densities to
5726 limit the potential for stand-replacement fire and competitive pressure on old trees.
- 5727 20. Conduct experiments to better understand how vegetation management treatments (e.g.,
5728 thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern
5729 Spotted Owl habitat, prey abundance and distribution, and demographic performance (see
5730 RA11).
- 5731 a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in
5732 use of burned areas for foraging warrants additional research on long-term use of
5733 burned areas post-fire.

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- 5734 21. Gather information on the effect of historical fire suppression and current fire regimes on owl
5735 habitat, especially on the quality of habitat as assessed through demographic rates at individual
5736 owl territories.
- 5737 22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of
5738 Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.
- 5739 23. Develop a process for evaluating the likely effects of post-fire management activities, such as
5740 salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate
5741 this process into post-fire management decisions.
- 5742 24. Concentrate post-fire silvicultural activities on conserving and restoring habitat elements that
5743 take a long time to develop, such as large trees, medium and large snags, downed wood (see
5744 RA12).
- 5745 Barred Owl
- 5746 25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy,
5747 reproduction, and survival in California (see RA23).
- 5748 26. Promote experimental removal of Barred Owls within Northern Spotted Owl range, and if lethal
5749 removal is deemed a long-term management tool to manage negative effects of Barred Owls,
5750 explore methods for implementation within California (see RA22, RA29, and RA30).
- 5751 27. Investigate the potential for resource partitioning of Barred Owls and Northern Spotted Owls
5752 (see RA26).
- 5753 28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted
5754 Owl interactions.
- 5755 a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by
5756 the presence or absence of Barred Owls, but other unknown factors may also play a
5757 role.
- 5758 Disease and Contaminants
- 5759 29. Monitor prevalence and extent of sudden oak death within the Northern Spotted Owl range in
5760 California, and address as appropriate (see RA17).
- 5761 30. Investigate the potential influences of sudden oak death on Northern Spotted Owl habitat,
5762 occupancy, and prey species abundance over the short- and long-term.
- 5763 31. Expand assessment of the impacts of marijuana cultivation (both illegal and legal) on the
5764 Northern Spotted Owl and their habitat.
- 5765 a. The watersheds analyzed to date comprise only 4% of the Northern Spotted Owl range.
5766 Uncertainties in the dataset analyzed make it likely that the density of legal cultivation

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5767 sites is higher than reported in the analysis. In addition, given the measured density of
5768 cultivation sites within Humboldt, Trinity and Mendocino counties potential impact of
5769 marijuana cultivation sites on spotted owl habitat should be evaluated further.

5770 b. Impacts of illegal cultivation to Northern Spotted Owls (e.g., habitat loss, exposure to
5771 toxins such and rodenticides) are largely unknown. Recent studies on anticoagulant
5772 exposure in fisher suggests some unknown impact to the owl since prey-base is shared
5773 between the two species.

5774 32. Monitor prevalence of avian diseases (e.g., West Nile Virus, avian flu, *Plasmodium* spp.) in the
5775 Northern Spotted Owl population, and address as appropriate (see RA17).

5776 33. Investigate the extent of stress induced impacts on Northern Spotted Owl reproduction and
5777 survival due to recreational activities (e.g., hiking, off-road vehicular use).

Listing Recommendation

[TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]

Protection Afforded by Listing

5781
5782 The following is a discussion of potential protection that could be afforded to the Northern Spotted Owl
5783 in California if listed under CESA. While the protections identified in this section would help to ensure
5784 the future conservation of Northern Spotted Owls, there are protections now in place that would
5785 continue if the owl were not listed under CESA. These include current protections afforded under the
5786 Northern Spotted Owl federal status, protections afforded under the Forest Practice Rules, coverage of
5787 the owl under HCPs and NCCPs, current CEQA requirements, and existing laws and regulations that
5788 make it illegal under State law to take owls in California.
5789

5790 It is the policy of the Department to conserve, protect, restore and enhance any endangered or any
5791 threatened species and its habitat (Fish & G. Code, § 2052.). The conservation, protection, and
5792 enhancement of listed species and their habitat is of statewide concern (Fish & G. Code, § 2051(c)).
5793 CESA defines “take” as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture,
5794 or kill. (Id. , § 86). Any person violating the take prohibition would be punishable under State law. When
5795 take is authorized through an incidental take permit, the impacts of the take must be minimized and
5796 fully mitigated, among other requirements.

5797 Increased protection of Northern Spotted Owl following listing would occur with required public agency
5798 environmental review under CEQA. CEQA requires affected public agencies to analyze and disclose
5799 project-related environmental effects, including potentially significant impacts on endangered, rare, and
5800 threatened species. Where significant impacts are identified under CEQA, the Department expects
5801 project-specific required avoidance, minimization, and mitigation measures will also benefit the species.

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5802 CEQA would require analysis of potential impacts to Northern Spotted Owl regardless of listing status
5803 under CESA. In common practice, potential impacts to listed species is examined more closely in CEQA
5804 documents than potential impacts to unlisted species. State listing, in this respect, and required
5805 consultation with the Department during state and local agency environmental review under CEQA, is
5806 also expected to benefit the species in terms of related impacts for individual projects that might
5807 otherwise occur absent listing.

5808 Without listing, Northern Spotted Owl take for research purposes is allowed via a Scientific Collecting
5809 Permit, and federal ESA 10a(1)(a). With listing, a state research Memoranda of Understanding (MOU)
5810 would also be required (Fish & G. Code, § 2081, subd. (a)). The added oversight allowed from MOU
5811 process is expected to benefit the species in terms of added coordination and research design, but will
5812 not likely add any additional protection.

5813 In listing the Northern Spotted Owl under CESA, the Department would expect an increased level of
5814 coordination among public agencies, such as USFS, CAL FIRE, and the USFWS, and with private timber
5815 companies, increased level of Department involvement in the THP review and approval process, more
5816 regular and thorough acquisition of data, and a reevaluation of current management practices for the
5817 species. In addition, if the Northern Spotted Owl is listed under CESA, the likelihood that land and
5818 resource management agencies will allocate funds towards protection and recovery actions may
5819 increase.

Economic Considerations

5820
5821
5822 The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).
5823

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Appendix 1. Forest Practice Rule definitions of silvicultural prescriptions.

The Forest Practice Rules differentiate silvicultural methods into four silvicultural categories. These silvicultural categories include even-aged management, uneven-aged management, intermediate treatments, and special prescriptions.

An Alternative silvicultural prescription can be included in a timber harvest plan when an alternative regeneration method or intermediate treatment is more effective or more feasible than any of the standard silvicultural methods.

Even-aged Management

Section 913.1 – Even-aged management are methods designed to replace a harvestable stand with well-spaced growing trees of commercial species.

Clearcutting

Section 913.1(b) – Clearcutting regeneration method involves the removal of a stand in one harvest.

Seed Tree

Section 913.1(c) – The seed tree regeneration method involves the removal of a stand in one harvest except for well distributed seed trees of desired species which are left singly or in groups to restock the harvested area.

Seed Tree Seed Step

Section 913.1(c)(1) – Seed Tree Seed Step: The seed tree seed step is the regeneration step and shall meet the following requirements:

(A) Retention of at least the following basal area of seed trees per acre which are 18 inches dbh or greater:

1. Fifteen square feet basal area on site I, II and III lands and
2. Twelve square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 150 feet from a seed tree.

(C) Seed tree species and site preparation measures shall be specified in the plan by the RPF.

(D) Seed trees shall be marked by or under the supervision of an RPF prior to felling operations.

(E) If natural regeneration is inadequate within two years after the first August following completion of timber operations, seed trees may be harvested and artificial regeneration shall be used to meet the requirements of Section 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)].

Seed Tree Removal Step

Section 913.1(c)(2) – No more than 15 predominant trees per acre may be removed in the seed tree removal step. Not more than 50 sq. ft. of basal area of predominant trees per acre may be removed in the seed tree removal step. The seed tree removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)].

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Shelterwood

Section 913.1(d) – The shelterwood regeneration method reproduces a stand via a series of harvests (preparatory, seed, and removal). The preparatory step is utilized to improve the crown development, seed production capacity and wind firmness of designated seed trees. The seed step is utilized to promote natural reproduction from seed. The removal step is utilized when a fully stocked stand of reproduction has become established, and this step includes the removal of the protective overstory trees. The shelterwood regeneration method is normally utilized when some shade canopy is considered desirable for the establishment of regeneration.

Shelterwood Preparatory Step

Section 913.1(d)(1) – The shelterwood preparatory step shall meet the following minimum standards:

(A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.

1. Thirty square feet basal area on site I, II and III lands and

2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 100 ft. from a seed tree.

(C) Seed tree species shall be specified in the plan by the RPF.

(D) At least 125 sq. ft. of basal area per acre on Site I lands, and 75 sq. ft. of basal area per acre on Site II and III lands and 50 sq. ft. of basal area per acre on site IV and V lands shall be retained.

(E) The minimum stocking standards of 14 CCR § 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)] shall be met immediately upon completion of operations.

Shelterwood Seed Step

Section 913.1(d)(2) – The shelterwood seed step is the regeneration step and shall meet the following standards:

(A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.

1. Thirty square feet basal area on site I, II and III lands and

2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 100 ft. from a seed tree.

(C) Seed tree species and site preparation measures shall be specified in the plan by the RPF.

(D) Seed trees shall be marked by or under the supervision of an RPF prior to felling operations.

(E) If natural regeneration is inadequate within two years after the first August following completion of timber operations, seed trees may be harvested and artificial regeneration shall be used to meet the requirements of 14 CCR § 912.7(b)(1), [932.7(b)(1), 952.7(b)(1)].

(F) In the absence of a Sustained Yield Plan, to maintain and improve tree species diversity, genetic material and seed production, trees of each native commercial species where present at the time of harvest shall be retained after harvest.

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6708 These leave trees shall be representative of the best phenotypes available in the
6709 preharvest stand. The RPF may propose and the Director may agree to a species
6710 specific plan in the THP which protects existing regeneration or provides for
6711 regeneration in-lieu of retaining trees.
6712

6713 Shelterwood Removal Step [Coast only]

6714 Section 933.1(d)(3) - The shelterwood removal step may be utilized when the
6715 regeneration present exceeds the minimum stocking requirements set forth in Section
6716 912.7(b)(1). Unless otherwise agreed to by the Director, the Shelterwood removal shall
6717 only be used once in the life of the stand. Regeneration shall not be harvested during
6718 the shelterwood removal step unless the trees are dead, dying or diseased or
6719 substantially damaged by timber operations. The minimum stocking standards of
6720 Section 912.7(b)(1) shall be met immediately upon completion of operations. The size
6721 limitations, and separation (spacing) by logical logging unit requirements, of Section
6722 913.1(a) are applicable unless the post-harvest stand, regardless of average diameter,
6723 meets the stocking standards of Section 913.3(a)(1)(A) or (B)]. Not more than 32
6724 predominant trees per acre may be removed in the shelterwood removal step. Not
6725 more than 100 square feet of basal area of predominant trees per acre may be removed
6726 in the shelterwood removal step.
6727

6728 Shelterwood Removal Step [Northern and Southern]

6729 The shelterwood removal step may be utilized when the regeneration present exceeds
6730 the minimum stocking requirements set forth in Section 932.7(b)(1) [952.7(b)(1)].
6731 Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used
6732 once in the life of the stand. Regeneration shall not be harvested during the
6733 shelterwood removal step unless the trees are dead, dying or diseased or substantially
6734 damaged by timber operations. The minimum stocking standards of Section 932.7(b)(1)
6735 [952.7(b)(1)] shall be met immediately upon completion of operations.
6736 If the extent and intensity of the ground disturbance caused by the harvest is essentially
6737 the same as would have been caused by a clearcut or will cause adverse cumulative
6738 effects on wildlife as determined by the RPF or Director, the size limitations, and
6739 separation (spacing) by logical logging unit requirements of Section 933.1(a) [953.1(a)]
6740 are applicable unless the post-harvest stand, regardless of average diameter, meets
6741 area stocking standards of Section 933.3(a)(1)(A) or (B) [953.3(a)(1)(A) or (B)].
6742

6743 **Uneven-aged Management**

6744 Sections 895.1 and 4593.2(c) – Uneven-aged management means the management of a specific forest,
6745 with the goal of establishing a well-stocked stand of various age classes and which permits the periodic
6746 harvest of individual or small groups of trees to realize the yield and continually establish a new crop.
6747 Also defined in the SAF Dictionary of Forestry as “a stand of trees of three or more distinct age classes,
6748 either intimately mixed or in small groups”.
6749

6750 Selection/Group Selection

6751 Section 913.2(a) – Under the selection regeneration method, the trees are removed individually
6752 or in small groups sized from 0.25 to 2.5 acres.
6753

6754 Transition

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Section 913.2(b) – The transition method may be used to develop an unevenaged stand from a stand that currently has an unbalanced irregular or evenaged structure. The transition method involves the removal of trees individually or in small groups from irregular or evenaged stands to create a balanced stand structure and to obtain natural reproduction.

Intermediate Treatments

Section 895.1 – Intermediate treatments means harvests conducted to modify or guide the development of an existing stand of trees, but not to replace (regenerate) the stand with a new one. The treatments involve the removal of trees to allow expansion of the crowns and root systems.

Commercial Thinning

Section 913.3(a) – Commercial thinning is the removal of trees in a young-growth stand maintain or increase average stand diameter of the residual crop trees, promote timber growth and/or improve forest health.

Sanitation-Salvage

Section 913.3(b) – Sanitation is the removal of insect attacked or diseased trees in order to maintain or improve the health of the stand. Salvage is the removal of only those trees which are dead, dying, or deteriorating, because of damage from fire, wind, insects, disease, flood or other injurious agent.

Special Prescriptions

Section 913.4 – Special Prescriptions are special harvesting methods which are appropriate under certain conditions.

Special Treatment Area

Sections 895.1 – Special Treatment Areas are specific locations which contain one or more of the following significant resource features which may be at risk during timber operations:

- a. Within 200 feet of the watercourse transition line of federal or state designated wild and scenic rivers;
- b. Within 200 feet of national, state, regional, county or municipal park boundaries;
- c. Key habitat areas of federal or state designated threatened, rare or endangered species;
- d. Coastal Commission special treatment areas;
- e. Within 200 feet of state designated scenic highways or within scenic corridors established pursuant to Article 2.5 (commencing with Section 260) of Chapter 2 of Division 1 and Section 154 of Chap. 1 of Div. 1 of the Streets and Highways Code.

Section 913.4(a) – Special consideration in Special Treatment Areas shall be given to selection of a regeneration method or intermediate treatment compatible with the objectives for which the special area was established. Such areas shall be identified in the plan. To assure the integrity of legally designated historical and archaeological sites and legally designated ecological reserves, and that the objectives of the special treatment areas are met, the RPF and the Director may agree, after on-the-ground inspection, if requested by either party, on specific silvicultural and logging practices to protect such areas. The Director shall notify affected agencies or groups with expertise in the resource involved in the special treatment area of any such areas located during the THP review process.

Rehabilitation

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6803 Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial
6804 timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7)
6805 prior to any timber operations on such lands, an area may be harvested provided it is restocked
6806 in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be
6807 included in the THP. The regeneration plan shall include site preparation, method of
6808 regeneration, and other information appropriate to evaluate the plan.
6809
6810 Fuelbreak/Defensible Space
6811 Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a
6812 shaded fuel break or defensible space in an area to reduce the potential for wildfires and the
6813 damage they might cause.
6814
6815 Variable Retention
6816 Section 913.4(d) - Variable retention is an approach to harvesting based on the retention of
6817 structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for
6818 integration into the post-harvest stand to achieve various ecological, social and geomorphic
6819 objectives.
6820
6821 Conversion
6822 Section 1100 – within non-timberland production zone (TPZ) timberland, transforming
6823 timberland to a nontimber growing use through timber operations.
6824
6825 **Alternative Prescription**
6826 A written analysis of preharvest and postharvest timber stand conditions and a description of the
6827 silvicultural practices and systems to be used in lieu of the standard methods. An Alternative silvicultural
6828 prescription can be included in a timber harvest plan when an alternative regeneration method or
6829 intermediate treatment is more effective or more feasible than any of the standard silvicultural
6830 methods.
6831 Section 913.6 – When an Alternative method is used, the plan must include a statement of which
6832 silvicultural method in the current District rules is most nearly appropriate or feasible and an
6833 explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how
6834 the proposed alternative prescription will differ from the most nearly feasible method in terms of
6835 securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in
6836 terms of fire, insect and disease protection.
6837
6838
6839 NonTimberland Area
6840 Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land,
6841 other than land owned by the federal government and land designated by the board as experimental
6842 forest land, which is available for, and capable of, growing a crop of trees of a commercial species used
6843 to produce lumber and other forest products, including Christmas trees.
6844
6845 Road Right of Way
6846 No strict definition
6847
6848

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6849 **Appendix 2: Forest Practice Rule definitions regarding Northern Spotted Owl or**
6850 **their habitat**

6851 **Activity Center (AC)** means a known northern Spotted Owl site documented from detections, pursuant
6852 to the USFWS document "Protocol For Surveying Proposed Management Activities That May Impact
6853 Northern Spotted Owls" revised March 17, 1992.

6854 (a) An AC is established by:

6855 (1) Resident Single Status is established by:

6856 (A) The presence or response of a single owl within the same general area on three or
6857 more occasions within a breeding season, with no response by an owl of the opposite
6858 sex after a complete survey;

6859 (B) Multiple responses over several years (i.e., two responses in year one and one
6860 response in year 2, from the same general area).

6861 (2) Pair Status Unknown is where the presence or response of two birds of the opposite sex is
6862 detected but pair status cannot be determined and where at least one member must meet the
6863 resident single requirements.

6864 (3) Pair Status wherein a male and female are heard and/or observed (either initially or through
6865 their movement) in proximity (less than one-quarter mile apart) to each other on the same visit;
6866 or a male takes a mouse to a female; or a female is detected on the nest; or one or both adults
6867 are observed with young.

6868 (4) Unoccupied Status where no responses have been obtained from a previously identified
6869 northern Spotted Owl activity center after 3 years of survey, barring other evidence to the
6870 contrary.

6871 An AC with unoccupied status will not be considered an AC when it has been evaluated and a
6872 determination made by the Director. The determination shall be based upon available information on
6873 survey history, habitat conditions within the home range, and changes to habitat that may have
6874 occurred since the northern Spotted Owl site was first identified.

6875 **Functional Foraging Habitat** is dependent upon the presence and availability of prey on the forest floor
6876 or in the canopy; presence of accessible perching limbs; and adjacency to stands with canopy closures
6877 >40%. Average stem diameter is usually >6" dbh for hardwoods and >11" dbh for conifers among
6878 dominants, and co-dominants, and the total overhead canopy closure, including intermediate trees is at
6879 least 40%. Where overall canopy closure is >80%, foraging habitat is limited to areas with ample flight
6880 space below limbs and among stems. Foraging habitat in smaller size classes and lower percentage
6881 canopy closures must be justified by local information.

6882 **Functional Nesting Habitat** means habitat with a dominant and co-dominant tree canopy closure of at
6883 least 40% and a total canopy (including dominant, co-dominant, and intermediates) of at least 60%.
6884 Usually the stand is distinctly multi-layered with an average stem diameter in dominant, and co-
6885 dominant conifers, and hardwoods >11" dbh. The stand usually consists of several tree species
6886 (including hardwoods) of mixed sizes. All nests, snags, down logs, and decadent trees shall also be
6887 considered as part of the habitat. Nesting substrates are provided by broken tops, cavities, or platforms

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6888 such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are
6889 known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with
6890 characteristics of topographic relief and aspect which alter microclimates.

6891 **Functional Roosting Habitat** during the territorial breeding season, consists of stands where
6892 average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers
6893 provide an average of at least 40% canopy closure but the stand can have a high degree of variability.
6894 Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for
6895 protection from various environmental conditions, including wind, heat, and precipitation.

6896 **Owl Habitat** means Type A, B, or C owl habitat or those areas with functional foraging habitat,
6897 functional nesting habitat, and functional roosting habitat which support the owl's biological needs for
6898 breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the
6899 functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls
6900 are known to occasionally inhabit less than optimal forest structure, local information can be used to
6901 justify the modification of functional habitat definitions.

6902 **Type A Owl Habitat** means timber stands that have as a minimum the following characteristics for
6903 live-tree structure:

- 6904 **1. Canopy layers:** The stand has two distinct tiers or is multi-layered with dominant
6905 conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for
6906 some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.
6907 **2. Canopy Closure:** The canopy closure of conifers greater than 120 ft. tall (or greater than
6908 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
6909 and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.
6910 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than nine
6911 stems per acre and not less than six stems per acre and includes a component of trees with sparse,
6912 broken, or dead tops.
6913 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6914 than 15 stems per acre and not less than 8 stems per acre.
6915 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
6916 than 50 stems per acre and not less than 20 stems per acre.
6917

6918 **Type B Owl Habitat** means timber stands that have as a minimum the following characteristics for
6919 live-tree structure:

- 6920 **1. Canopy Layers:** Moderately to strongly two-tiered or multi-layered with dominant
6921 conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some
6922 montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.
6923 **2. Canopy Closure:** The canopy closure of conifers greater than 100 ft. tall (or greater than
6924 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
6925 and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.
6926 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than six

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6927 stems per acre and not less than two stems per acre.
6928 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6929 than 25 stems per acre and not less than 20 stems per acre.
6930 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
6931 than 50 stems per acre and not less than 20 stems per acre.

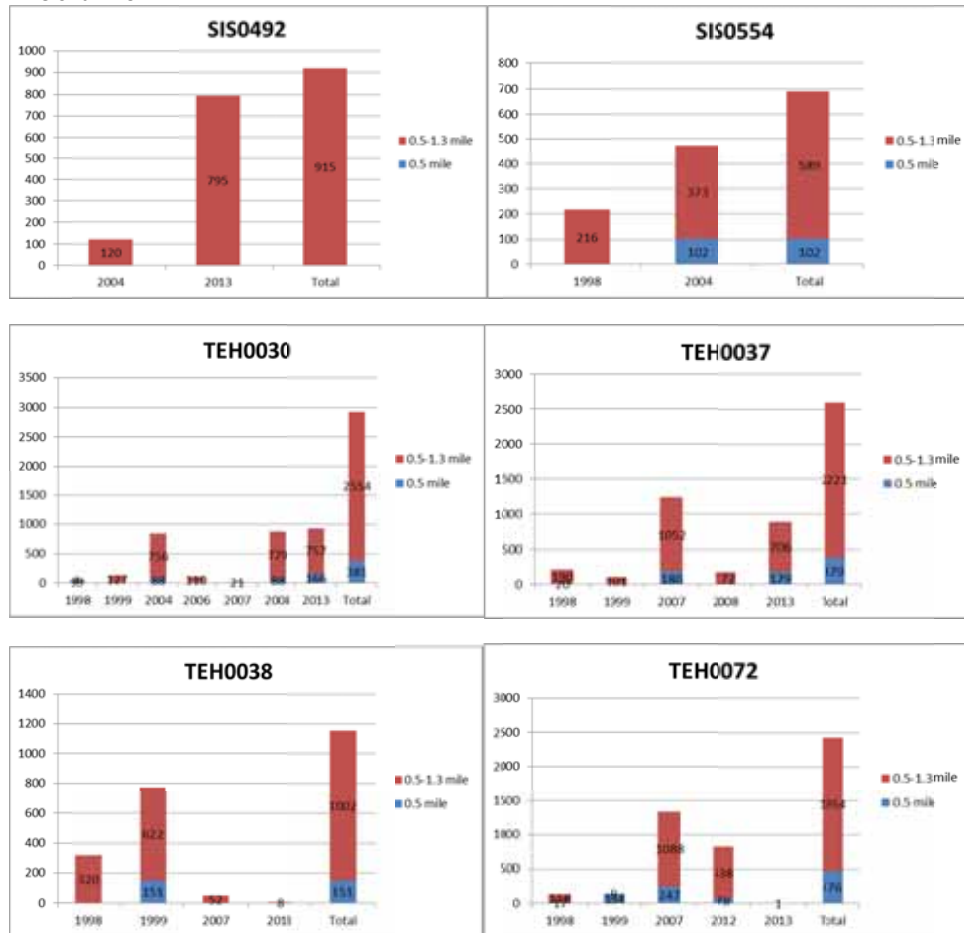
6932 **Type C Owl Habitat** means timber stands that have as a minimum the following characteristics for
6933 live-tree structure:
6934 **1. Canopy Layers:** Uniform to moderately layered with dominant conifers or hardwoods 50
6935 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.
6936 **2. Canopy Closure:** The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages
6937 greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is
6938 greater than 60%.
6939 **3. Large Trees:** The density of conifers greater than 35 inches dbh averages less than six
6940 stems per acre and may be absent.
6941 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6942 than 15 stems per acre, but may be absent.
6943 **5. Small Trees:** The density of conifers or hardwoods less than 18 inches dbh averages
6944 more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the
6945 stand, including small, medium, and large trees is greater than 10 inches.

6946

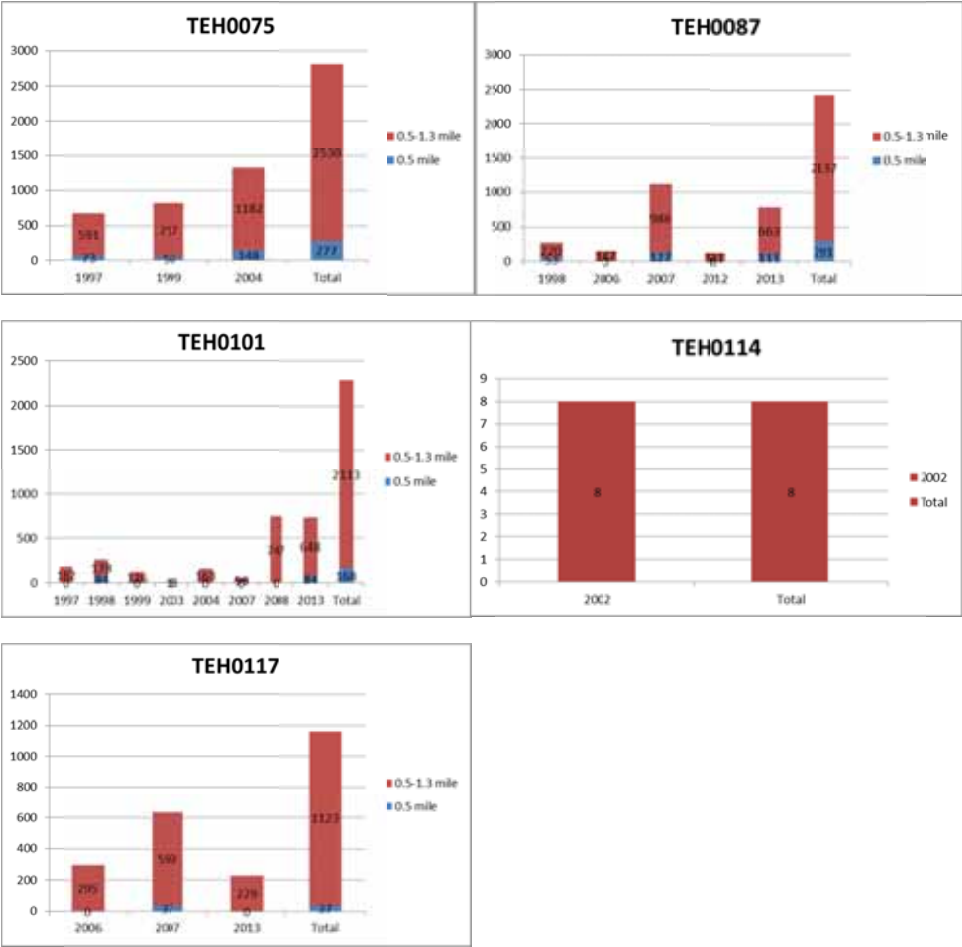
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Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

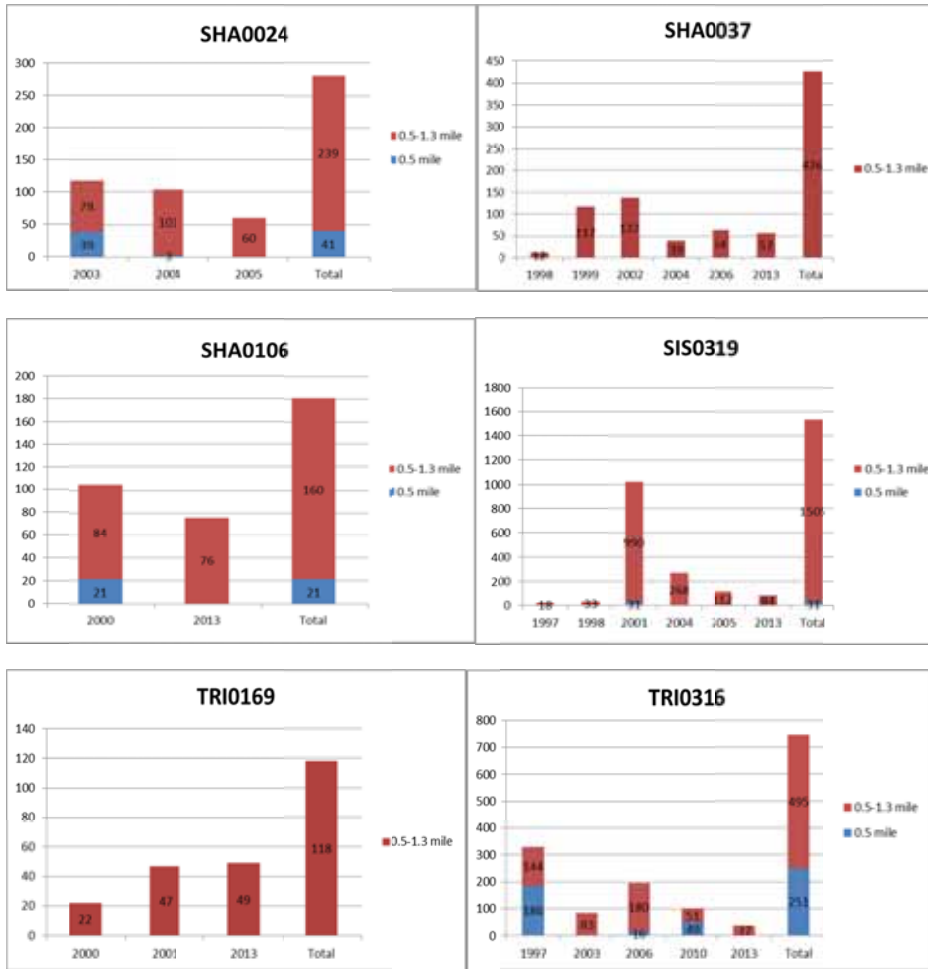


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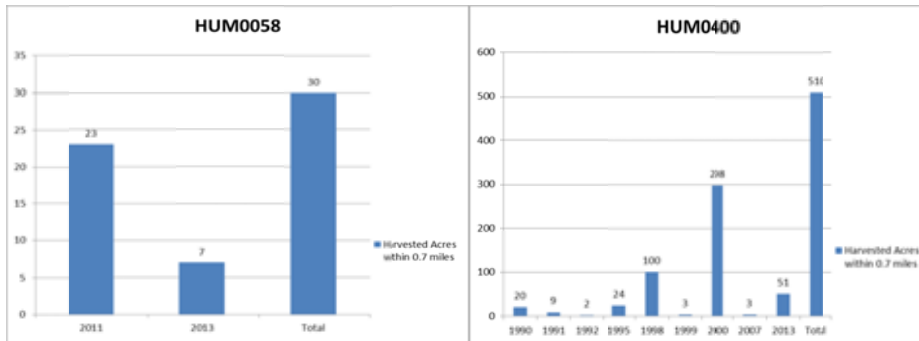
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6962 THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3
6963 mile of an AC

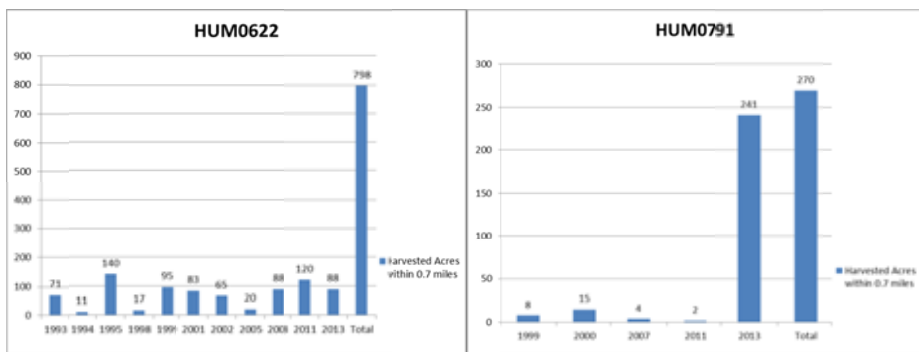


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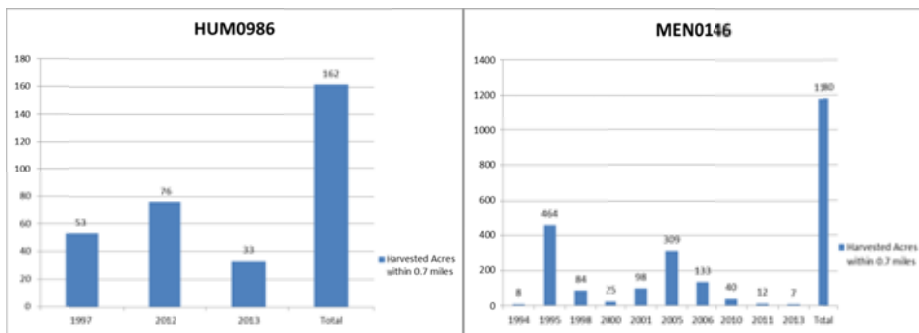
6963 THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



6968

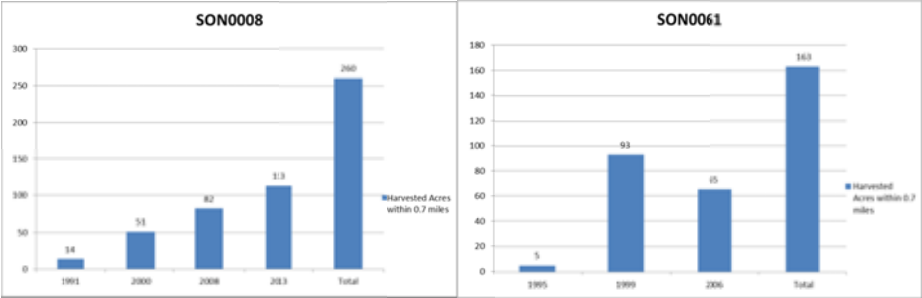
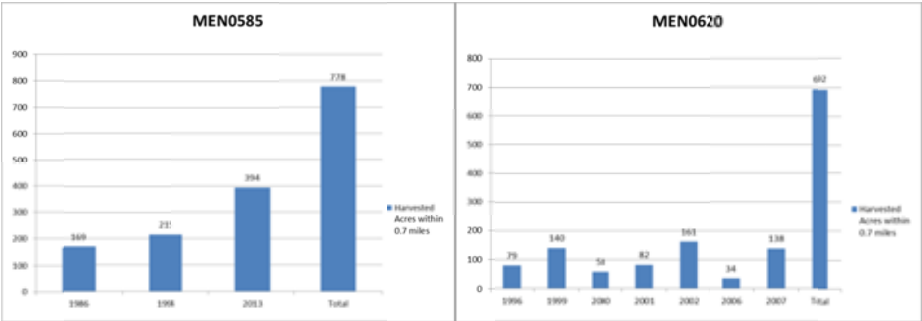
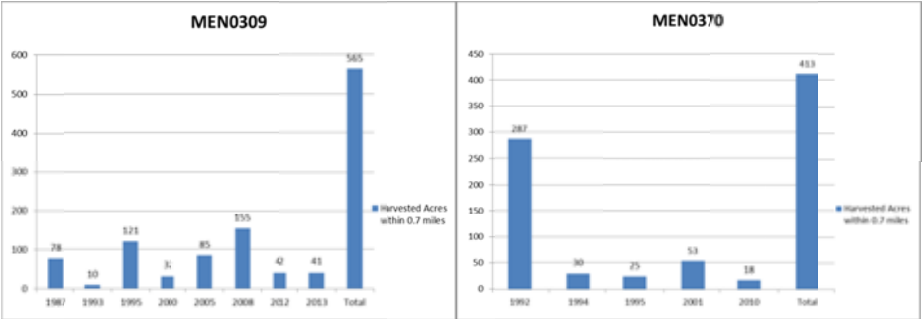


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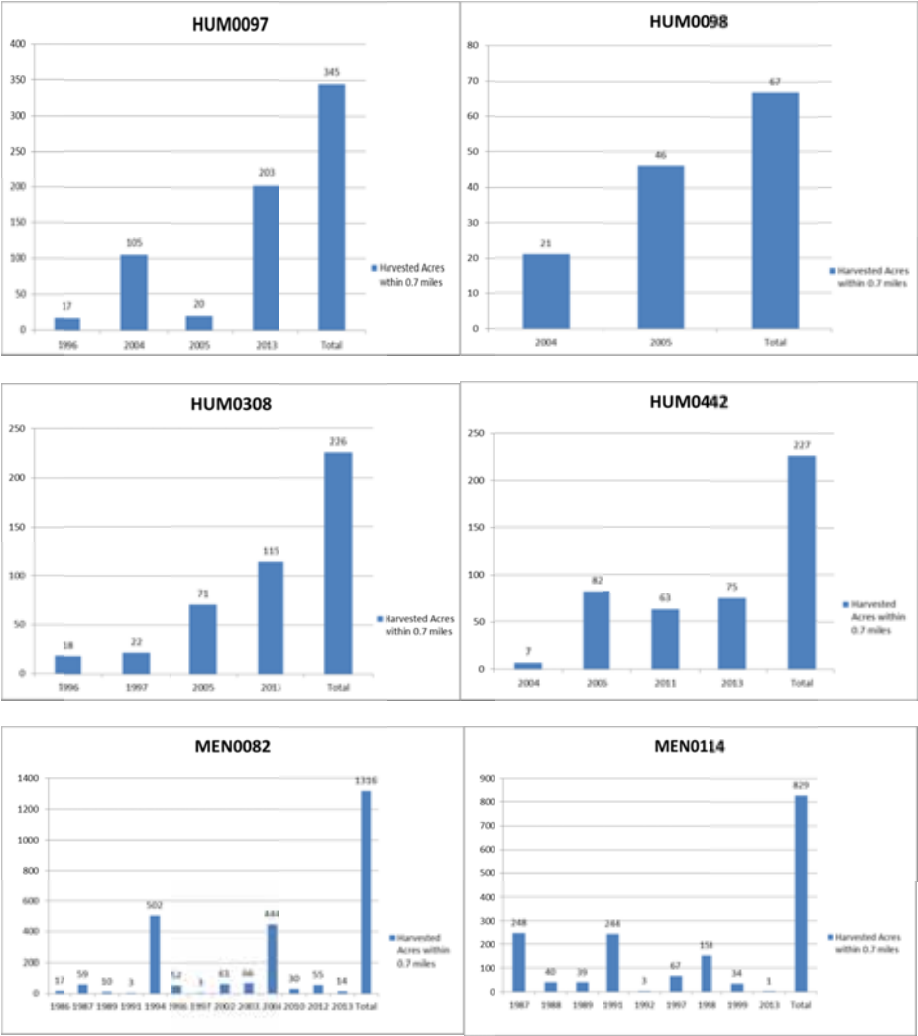
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6977 THP’s utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



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6982	Appendix 4. List of Acronyms and Abbreviations	
6983		
6984	AC	Activity Center
6985	AMA	Adaptive Management Areas
6986	AR	Anticoagulant Rodenticides
6987	BLM	Bureau of Land Management
6988	Board	Board of Forestry and Fire Protection
6989	BO	Biological Opinion
6990	BOE	Board of Equalization
6991	BOF	State Board of Forestry and Fire Protection
6992	CA State Parks	California Department of Parks and Recreation
6993	CAL FIRE	California Department of Forestry and Fire Protection
6994	Caltrans	California Department of Transportation
6995	CBD	Center for Biological Diversity
6996	CD	Consistency Determination
6997	CEQA	California Environmental Quality Act
6998	CESA	California Endangered Species Act
6999	CCAA	Candidate Conservation Agreement with Assurances
7000	CDFW	California Department of Fish and Wildlife
7001	CI	Confidence Interval
7002	CNDDDB	California Natural Diversity Database
7003	Commission	Fish and Game Commission
7004	CPV	Canine Parvovirus
7005	CSA	Conservation Support Areas
7006	CWHR	California Wildlife Habitat Relationships
7007	DBH	Diameter at Breast Height
7008	DSA	Density Study Area
7009	Department	California Department of Fish and Wildlife
7010	EIR	Environmental Impact Report
7011	EPA	Environmental Protection Agency
7012	ESA	Federal Endangered Species Act
7013	FEIS	Final Environmental Impact Statement
7014	FRGP	Fisheries Restoration Grant Program
7015	FGS	Fruit Growers Supply Company
7016	FEMAT	Forest Ecosystem Management Assessment Team
7017	FIA	Forest Inventory Analysis
7018	FMP	Forest Management Plan
7019	FPA	Forest Practice Act
7020	FRI	Fire Return Interval
7021	FSC	Forest Stewardship Council
7022	GDR	Green Diamond Resource Company study area
7023	GDRC	Green Diamond Resource Company
7024	ITP	Incidental Take Permit
7025	ITS	Incidental Take Statement
7026	JDSF	Jackson Demonstration State Forest
7027	HCP	Habitat Conservation Plan
7028	HFP	Habitat Fitness Potential

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7029	HCVF	High Conservation Value Forests
7030	HUP	Hoopa Indian Reservation study area
7031	HRC	Humboldt Redwood Company
7032	LSA	Late-Successional Areas
7033	LSAA	Lake or Streambed Alteration Agreement
7034	LSR	Late-Successional Reserve
7035	MBF	1,000 board-foot
7036	MIS	Management Indicator Species
7037	MMCA	Marbled Murrelet Conservation Areas
7038	MRC	Mendocino Redwood Company
7039	NCA	National Conservation Area
7040	NCCP	Natural Community Conservation Plan
7041	NIPF	Non-industrial private forest
7042	NPS	National Park Service
7043	NSO	Northern Spotted Owl
7044	NTMP	Nonindustrial Timber Management Plans
7045	NTO	Notice of Operations
7046	NWC	Northwest California study area
7047	NWFP	Northwest Forest Plan
7048	ORV	Off Road Vehicle
7049	PCB	Private Consulting Biologists
7050	PFT	Pacific Forest Trust
7051	PL	Pacific Lumber Company
7052	PRNS	Point Reyes National Seashore
7053	PSU	Primary Sampling Unit
7054	REF	Suppressed reproduction and growth
7055	RNSP	Redwood National and State Parks
7056	ROD	Record of Decision
7057	RPF	Registered Professional Foresters
7058	SEIS	Supplemental Environmental Impact Statement
7059	SHA	Safe Harbor Agreement
7060	SOMP	Spotted Owl Management Plans
7061	SOP	Spotted Owl Expert
7062	SORP	Spotted Owl Resource Plan
7063	SFI	Sustainable Forestry Initiative
7064	SP	State Park
7065	SPI	Sierra Pacific Industries
7066	TCP	Timberland Conservation Planning Program
7067	THP	Timber Harvest Plan
7068	TPZ	Timber Production Zone
7069	UCNRS	UC Natural Reserve System
7070	USFWS	U.S. Fish and Wildlife Service
7071	USFS	U.S. Forest Service
7072	USDA	United States Department of Agriculture
7073	USDI	United States Department of Interior
7074	USFS	United States Forest Service
7075	WCSA	Willow Creek Study Area
7076	WLPZ	Watercourse and Lake Protection Zones

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7077 WNV West Nile virus
7078

From: [Dugger, Katie](#)
To: [Clipperton, Neil@Wildlife](#)
Cc: [Battistone, Carie@Wildlife](#)
Subject: RE: NSO status review
Date: Thursday, January 07, 2016 10:25:05 AM
Attachments: [image001.jpg](#)
[Summary Demographic Rates_03Jan2016_Clean_KMD.docx](#)
[Status and Trends_03Jan2016_Clean_KMD.docx](#)

Hi Neil and Carie,

See my comments on the demographic section and also your “summary” attached. I think these sections are looking good and most of my comments/editorial suggestions are attempts to reduce redundancy and help you walk that line between providing too much “methods” or analytical details, while still being clear about the reliability of the results you’re presenting. One problem is of course how to handle the “grey literature” and industry reports, which under most circumstances I would say should not be included. However, I know you would probably be criticized by the industry for leaving those documents out, so including them is probably your best option. Unfortunately I think much of data from the industry sources is not collected or analyzed in a way that allows them to generate unbiased estimates of owl demography, which is why little of it has been subjected to scientific peer-review, but I think you did a good job presenting those data with the appropriate caveats.

Hope this helps and good luck with the revisions!

Katie

From: Clipperton, Neil@Wildlife [mailto:Neil.Clipperton@wildlife.ca.gov]
Sent: Sunday, January 03, 2016 4:31 PM
To: Dugger, Katie
Cc: Battistone, Carie@Wildlife
Subject: RE: NSO status review

Hi Katie,

Thank you again for agreeing to review the updated version of the Demographic Rates section of the Northern Spotted Owl status review. We have revised the section extensively based on the results of the recently published meta-analysis. I am attaching two versions: one clean and one with “track changes” in case you would like to see how we responded to peer review comments from you and others. I ask that you please make any additional edits and comments on the clean version so that we can plug it into our working draft of the status review.

I am also attaching a 1.5 page summary of the abundance and demographic rates of Northern Spotted Owl in California. This summary occurs in a separate section of the status review. The California Fish and Game Commission is required to make decisions on whether to list species as threatened or endangered based on a set of specific factors, and in developing status reviews to inform the Commission's decision, the Department traditionally includes a section entitled "Summary of Listing Factors" which very concisely summarizes information in the status review. If you have time to review this short summary it would be much appreciated.

Thank you very much. Your previous input has greatly improved our document and we are sure that your additional review will help us make the status review even better.

Please let Carie or I know if you have any questions.

Neil

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From: Dugger, Katie [<mailto:katie.dugger@oregonstate.edu>]
Sent: Wednesday, December 23, 2015 10:59 AM
To: Clipperton, Neil@Wildlife
Cc: Battistone, Carie@Wildlife
Subject: RE: NSO status review

Hi Neil and Carie,

I'd be happy to review the demographic parts of your status review again as long as that week of January 4th will work. I've got a family obligation next week that will keep me tied up, but can probably do a review by COB Friday the 8th – and I'll try and have it done earlier if I can manage it.

Will that work?

Katie

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Status and Trends in California

Abundance

No range-wide estimate for abundance of Northern Spotted Owl exists because survey methods and effort conducted to date do not provide for reliable estimation of population size across the species' range (USFWS 2011). Few areas across Washington, Oregon and California have been sufficiently sampled to accurately estimate densities of Northern Spotted Owls (Franklin et al. 1990, Tanner and Gutiérrez 1995, Diller and Thome 1999). As mentioned above, Northern Spotted Owl densities vary across the range and forest types and so extrapolating the few local estimates across the range of the subspecies would result in biased estimates of abundance (See Life History section of this report for detailed information on density estimates in California). Because Northern Spotted Owls have large home ranges it is necessary to systematically survey very large areas in order to obtain reliable estimates of density (Franklin et al. 1990). In addition, detection rates of spotted owls during nighttime call surveys vary widely, but are generally <1.0 (Olson et al. 2005, Anthony et al. 2006, Kroll et al. 2010, Forsman et al. 2011, Dugger et al. 2009, 2011). Current survey techniques do not effectively sample nonterritorial individuals (floaters), and may vary for territorial birds relative to whether they are breeding or not in any given year (Anthony et al. 2006, Forsman et al. 2011, Stoelting et al. 2015). Finally, the presence of barred owls in the landscape can decrease the detection rates of spotted owls, in some cases, very dramatically (Olson et al. 2005, Crozier et al. 2006, Kroll et al. 2010, Wiens et al. 2011, Dugger et al. 2009, 2011). Thus, without an effective sampling method that addresses the inability to detect all owls in a given area, it is not possible to provide an accurate estimate of abundance. See the discussion on occupancy in the Demographic Rates section of this report for potential effects of floater owls on occupancy rates at known owl sites.

A recent study made use of the immense amount of data available on Northern Spotted Owl habitat requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity, dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the range of the owl (Schumaker et al. 2014). In addition to an evaluation of source-sink dynamics, outcomes of the model included a range-wide population size estimate, and the proportion of the population in each modeling region and physiographic province noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011). Simulated estimates of population size by geographic region indicate that Northern Spotted Owls are most abundant in parts of southern Oregon and northern California (Table 5). The three California provinces were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population. The model indicated that the Klamath region is a stronghold for the population, with 50.1 percent cumulatively within the Oregon Klamath and California Klamath provinces, and 37.1 percent within the Klamath East and Klamath West modeling regions. Schumaker et al. (2014) estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions. Although informed by the best available data to develop an impressive assessment of source-sink dynamics across the range, the complexity of the model may limit its ability to

accurately model population estimates. For example, differences in the simulated number of owls versus the numbers observed in eight demographic study areas used for calibration ranged from 5 to 47 percent (Schumaker et al. 2014). For these reasons the results might best be treated as hypotheses rather than concrete inferences about northern spotted owl populations. Nevertheless, the results suggest that California's population of Northern Spotted Owls is an important component of the range-wide population.

Table 5. Percent of range-wide Northern Spotted Owl population within modeling region and physiographic province based on simulation models (adapted from Table 2 in Schumaker et al. 2014).

Modeling Region	Percent of Population	Physiographic Province	Percent of Population
North Coast Olympics	0.1	Washington Western Cascades	1.3
West Cascades North	0.1	Washington Eastern Cascades	1.6
East Cascades North	3.3	Washington Olympic Peninsula	>0.0
West Cascades Central	1.2	Washington Western Lowland	>0.0
Oregon Coast	1.0	Oregon Eastern Cascades	3.5
West Cascades South	15.3	Oregon Western Cascades	23.3
Klamath West	20.0	Oregon Coast	0.8
Klamath East	17.1	Oregon Willamette Valley	>0.0
Redwood Coast	16.4	Oregon Klamath	13.7
East Cascade South	3.8	California Coast	16.6
Inner California Coast	21.7	California Cascades	2.8
		California Klamath	36.4

Most surveys for Northern Spotted Owls have been conducted on areas proposed for timber management activities in order to assess the potential for impacting the species (citation?), or on demographic study areas where long-term research has been conducted throughout the subspecies range (e.g., Forsman et al. 2011, Dugger et al. 2016). Although not designed for estimating density or abundance, pre-harvest surveys have dramatically increased knowledge on location of territorial owl sites (i.e., activity centers). As survey effort has expanded to new areas over time, the number of known activity centers has naturally increased. Although owls will shift locations of activity centers over time in response to changing forest landscapes, they exhibit high site fidelity to general nesting and roosting areas (Gutiérrez et al. 1995, Blakesley et al. 2006), therefore the increase in number of activity centers over time is more likely a result of expanded survey effort than establishment of new owl territories. In addition, across most of the Northern Spotted Owl range establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a slow process given tree species growth rate (Davis et al. 2015), and so a rapid increase in the number of activity centers due to colonization of new habitat is unlikely. Compared with other portions of the range, habitat development through forest maturation can occur relatively quickly on the redwood coast where Northern Spotted Owls have been shown to select relatively young forests (41-60 years old) for nesting and roosting, as long as all habitat requirements are present (Thome et al. 1999). For example, Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature (GDRC 2015). However, the annual number of known Northern Spotted Owl sites on GDRC lands ranged

from 99 to 186 from 1991 through 2014 (mean 134.5), with 122 sites known in 2014 (GDRC 2015), so new sites have not necessarily indicated a growing population. The number of newly established activity centers across the range as a result of newly available nesting and roosting habitat is unknown, but is likely small given that very little new suitable nesting and roosting habitat has developed in recent decades, and total acreage of suitable habitat has declined (Davis et al. 2015). See the discussion on habitat changes in the threats section for additional information on the topic of habitat recruitment.

In California, the number of known Northern Spotted Owl activity centers rapidly increased starting around 1990 when listing under the federal Endangered Species Act resulted in a widespread increase in survey effort (Figure 3). Through 1989, there were 1,366 known Northern Spotted Owl activity centers in California. By the year 1999, this number had increased dramatically to 2,799. As of 2014, the number of known Northern Spotted Owl activity centers was 3,116. The number of occupied activity centers in any given year is unknown because not all areas have been or can be surveyed on an annual basis (USFWS 2011). An increase in incidental detections of Barred Owls concurrent with an increase in Spotted Owl activity centers may also demonstrate an increase in survey effort (see Figure 28 in the Threats section of this report). Some unknown portion of ~~historic the~~ Northern Spotted Owl sites are unoccupied in any given year because of habitat loss due to timber harvest or severe fires (Davis et al. 2015), displacement by Barred Owls (HRC 2015), normal death of owls or their movement out of established territories, or other factors, therefore much of the data from early survey reports are outdated and of little use in addressing population abundance or distribution questions (Courtney et al. 2004). ~~These movements and displacements of Spotted Owls are likely responsible for some of the observed increase in known activity centers.~~ For these reasons and for the sampling reasons discussed above, the number of activity centers does not represent an index of abundance but rather the cumulative number of territories recorded as being in use by Northern Spotted Owl at some point in ever-time across in a dynamic landscape (USFWS 2011).

Demographic Rates

“Because the existing survey coverage and effort are insufficient to produce reliable range-wide estimates of population size, demographic data are used to evaluate trends in Spotted Owl populations” – USFWS (2011).

The U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) initiated eight long-term demography studies within the range of the Northern Spotted Owl during the years 1985 to 1991 in order to provide data on the status and trends of Spotted Owl populations, and to inform the effectiveness of the NWFP on federal lands (Lint et al. 1999). In important part of the effectiveness monitoring program was the regular analysis of the data to estimate the status and trends of Northern Spotted Owls on federal lands (Lint et al. 1999). Thus, since an initial analysis in 1991 (Anderson and Burnham 1992) and another in 1993 (Burnham et al. 1994, 1996), every 5 years or so a meta-analyses of these data and data from other long-term demographic study areas are analyzed to estimate Northern Spotted Owl vital rates and more recently, to investigate the factors associated with variation in these vital rates across the species’ range (e.g., Franklin et al. 1999; Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016). The most recent meta-analysis conducted in January 2014 included 11 study areas

including 3 areas in Washington, 5 in Oregon and 3 in Northern California representing primarily federal, or mixed private/federal ownerships (Table 6; Dugger et al. 2016). Additional demographic study areas that were not established under the NWFP were also initiated in the late 1980s and early 1990s. The three additional study areas that are currently active include one entirely on private land (i.e., Green Diamond Resource Company), one on the Hoopa Indian Reservation land, and one composed of a mix of federal, private, and state lands (i.e., Rainer). These long-term Northern Spotted Owl demographic study areas, range between Washington and northern California, and collectively represent about 9% of the range of the Northern Spotted Owl (Forsman et al. 2011; Figure 7). The authors that coordinate and analyze data from the eleven study areas believe the results are representative of Northern Spotted Owl populations on federal, and on mixed federal and private lands because the study areas 1) encompassed 9% of the total range of the Northern Spotted Owl, 2) contained most habitat types used by the owl, and 3) contained elements of most of the physiographic provinces in which the owl occurs (Forsman et al. 2011; Dugger et al. 2016; Figure 7). Thus, results from these study areas are believed to represent the status of Northern Spotted Owl populations on federal, and mixed private and federal lands across the species range. However, The results likely depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands because the three non-federal study areas are actively managed to protect Northern Spotted Owls and their habitat (Forsman et al. 2011, Dugger et al. 2016).

All These eleven study areas were surveyed have been monitored annually since inception and 22-29 years of data through 2013 were available for the 2014 meta-analysis have accumulated between 24 and 31 years of breeding season data through 2015 (Dugger et al. 2016; Table 6). Standard protocols were used on all study areas ensure that efforts to determine historic site occupancy, to band and resight all territorial owls, and to assess nesting status of territorial females were consistent across all study areas (Forsman 1995, Franklin et al. 1996, Lint et al. 1999). The resulting survey data allows for the estimation of fecundity, apparent survival, recruitment, annual rates of population change, territory occupancy, and occupancy dynamics (i.e., local territory colonization and extinction rates) (Dugger et al. 2016). Northern Spotted Owl vital rates are evaluated separately for on each individual study area and also using data from all study areas combined across all study areas combined (i.e., meta-analysis). Most recently, in addition to the estimation of vital rates and trends, a suite of factors were investigated to determine potential effects on population vital rates, including Barred Owl presence, amount of suitable habitat, local weather, and regional climate patterns (Dugger et al. 2016). or a range-wide, assessment of population status and trends (meta-analysis). On each study area, territorial owls are captured and banded, followed by annual attempts to recapture or resight owls and to evaluate reproductive success of territorial pairs. Standard protocols ensure consistent and thorough attempts to band and resight territorial owls and to assess nesting status of territorial females (Franklin et al. 1996, Anthony et al. 2006). The most recent compilation of data included survey years through 2013; over the period of 22-29 years (depending on study area) capture histories have been recorded for a total of 5,992 territorial owls, which included 29,520 annual observations of marked owls. The number of young produced by territorial females was determined in 12,969 separate cases (Dugger et al. 2016). In addition to these data, recording of the presence or absence of territorial owls during surveys at each Northern Spotted Owl territory allowed for estimation of territory occupancy rates. These meta-

Comment [DK1]: So the history of the demographic study areas included in the meta-analysis is relatively complex – While the 8 federally funded areas included has been constant, additional areas have ranged from 7 to 3 and it's probably not worth going into that history in too much detail.

147 | [analyses demographic studies, which include three California study areas](#), likely represent the best
148 | population demographic information on an endangered species ever assembled (Gutiérrez 2008).

149 | **Table 6.** Descriptions of 11 demographic study areas used to assess vital rates and population trends
150 | through 2013 in Washington, Oregon, and California. Adapted from Tables 2 and 3 in Dugger et al. (2016).

Study Area	Area Code	Start Year	Area (km ²)	Ownership
Washington				
Cle Elum*	CLE	1989	1,784	Mixed
Rainier	RAI	1992	2,167	Mixed
Olympic*	OLY	1990	2,230	Federal
Oregon				
Coast Ranges*	COA	1990	3,922	Mixed
H.J. Andrews*	HJA	1987	1,604	Federal
Tyee*	TYE	1990	1,026	Mixed
Klamath*	KLA	1990	1,422	Mixed
South Cascades*	CAS	1991	3,377	Federal
California				
NW California*	NWC	1985	460	Federal
Hoopa Tribe	HUP	1992	356	Tribal
Green Diamond Resources	GDR	1990	1,465	Private

151 | *Indicates the eight study areas that are part of the federal monitoring program for the Northern Spotted Owl.

152 | [The collection of an enormous amount of data over a long time period allows for estimation of vital](#)
153 | [rates across a large portion of the Northern Spotted Owl range. Data from the demographic study areas](#)
154 | [have been compiled and analyzed regularly, with the most recent analysis covering all survey years](#)
155 | [through 2013 \(Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al.](#)
156 | [2006, Forsman et al. 2011, Dugger et al. 2016\). The most recent analysis of the data \(Dugger et al. 2016\)](#)
157 | [is the 6th time data from these study areas were used to assess range-wide population status and trends](#)
158 | [of Northern Spotted Owl. Vital rates are evaluated on each individual study area and also using data](#)
159 | [from all study areas combined for a range-wide assessment of population status and trends \(meta-](#)
160 | [analysis\). Vital rates estimated include apparent survival, fecundity, recruitment, rate of population](#)
161 | [change, and site occupancy rates based on local extinction and colonization rates. Along with estimation](#)
162 | [of rates and trends, a suite of factors were investigated to determine potential effects on population](#)
163 | [vital rates, including Barred Owl presence, amount of suitable habitat, local weather, and regional](#)
164 | [climate patterns.](#)

165 | As discussed above, data collected from existing surveys are not sufficient to estimate population size,
166 | [or density of Northern Spotted owls, and so trends in the absolute number of owls on each study](#)
167 | [areas over time cannot be assessed. population trends cannot be assessed by comparing estimates of](#)
168 | [population size over time. However, the consistent collection of large amounts of capture-recapture](#)
169 | [data and observations of reproductive effort has resulted in an enormous amount of information which](#)
170 | [allows for estimation of the annual rate of population change for territorial spotted owls \(i.e., lambda -](#)

171 λ), which reflects changes in population size from one year to the next due to resulting from annual
172 reproduction, mortality, and movement into and out of a study area can be estimated from the data
173 collected on these long-term demographic study areas (e.g., Anthony et al. 2006, Forsman et al. 2011,
174 Dugger et al. 2016). Lambda does not provide a numerical estimate of population size, but instead
175 estimates the rate of change in a population from one year to the next.

176 Decomposition of λ into apparent survival and recruitment allows for evaluation of the population
177 parameters that may be influencing observed rates of population change (i.e. losses vs. gains to the
178 population during each year). In this case apparent survival reflects both survival and emigration from
179 the study area; recruitment represents the number of new animals entering the population including
180 both *in situ* recruitment and immigration of recruits from outside the study area (Dugger et al. 2016).
181 Modeling of adult apparent survival and fecundity is also conducted independently of λ on individual
182 study areas to allow for estimation of these parameters independent of immigration and for
183 investigation of covariates that influence these vital rates (i.e. factors that affect survival or reproduction
184 of Northern Spotted Owls). Occupancy was modeled at the territory scale and provides an additional
185 assessment of population status using data on presence or absence of owls at known sites. In sum, this
186 thorough assessment of population parameters and factors that influence them provides a detailed
187 evaluation of status and trends of Northern Spotted Owl populations, and provides important
188 information on factors influencing populations that can inform management and conservation.

Comment [DK2]: Not true – immigration and emigration are inherent components of “apparent survival” – they just can’t be estimated separately (well, not given the models we used here).

189 The three Northern Spotted Owl demographic study areas located in California and included in the most
190 recent meta-analysis represent a diverse land ownership; the Northwest California study area (NWC) is
191 primarily on federal land, the Green Diamond Resource Company study area (GDR) is on private land,
192 and the Hoopa Indian Reservation study area (HUP) is on tribal land. These three study areas cover
193 approximately 6% of the range of the Northern Spotted Owl in California (based on the USFWS range).
194 The NWC and HUP study areas were characterized by mixtures of mature and old-growth forest
195 interspersed with young forests regenerating on areas that had been clear-cut or burned. On the GDR
196 study area, nearly all stands of old trees had been clear-cut and converted to young forests that were
197 less than 70 years old (Dugger et al. 2016). In 2009, a Barred Owl removal study was implemented on
198 the GDR study area by partitioning the study area into treatment (Barred Owls lethally removed) and
199 control (Barred Owls undisturbed) areas (Diller et al. 2014, Dugger et al. 2016). The treatment and
200 control areas were evaluated separately to estimate the response of Northern Spotted Owl vital rates to
201 the removal activities. This study is discussed in detail in the Barred Owl threat section of this report,
202 and is also referenced in this section as necessary.

Comment [DK3]: This section is not entirely true. Yes, we estimated “recruitment” using the lambda analysis, but we did that within a meta-analysis only (all study areas combined) and did not model survival within that analysis (just left general temporal effects on Phi). We only modeled survival and the factors that affected it using a basic CJS on both the individual study area basis and also all study areas combined. So what actually went on and why, is more complicated than what you’ve got here – however, I honestly don’t think you need this paragraph at all – details of methodology can be found in the primary publication, so I’m not sure you need to reiterate any of that here.

Comment [DK4]: ?? – do you mean from the Critical Habitat document? You should include the specific source here.

203 ~~The authors that coordinate and analyze data from the eleven study areas believe the results are~~
204 ~~representative of Northern Spotted Owl populations on federal, and on mixed federal and private lands~~
205 ~~because the study areas 1) encompassed 9% of the total range of the Northern Spotted Owl, 2)~~
206 ~~contained most habitat types used by the owl, and 3) contained elements of most of the physiographic~~
207 ~~provinces in which the owl occurs (Dugger et al. 2016). The results likely depict an optimistic view of the~~
208 ~~overall population status of the Northern Spotted Owl on private lands because the three non-federal~~
209 ~~study areas are actively managed to protect Northern Spotted Owls and their habitat (Forsman et al.~~
210 ~~2011, Dugger et al. 2016).~~ In California, the California Klamath and California Coast physiographic

Comment [DK5]: I moved this up above with the rest of the study area discussion associated with 11 study areas in recent meta-analysis.

provinces are represented by the NWC, HUP, and GDR study areas. There is no demographic study area in the California Cascades physiographic province, but the South Cascades study area (CAS) is just across the border in Oregon, and inferences can be drawn from that study area. Also, a study conducted in the California Cascades provides valuable information on occupancy rates and trends in that physiographic province (Farber and Kroll 2012).

Below, we discuss ~~estimates of results of modeling for the annual~~ rate of population change, fecundity, survival, and occupancy at each of the study areas in California and ~~the environmental factors that are associated with variation in these demographic rates from the most recent Northern Spotted Owl meta-analysis (Dugger et al. 2016). We~~ report results of ~~the larger~~ range-wide assessments ~~where appropriate to put the results from the California study areas into to provide a the~~ broader rangewide perspective. ~~In addition, we report r~~Results from CAS in southern Oregon ~~are also reported~~ because the study area occurs directly north of the California Cascades province and ~~so~~ may reflect ~~potential~~ changes in the California Cascades. Few studies conducted outside the demographic study areas have collected the necessary data to assess ~~most of these spotted owl~~ vital rates, but in several cases presence-absence data is available with which site occupancy modeling ~~was can be~~ conducted (e.g., citations??). ~~In the discussion of occupancy, Thus, we present results from other studies where additional data is available e discuss additional studies that have occurred ou~~outside of the 11 long-term demographic study areas, ~~in order to provide information on population status outside of the large study areas.~~

Comment [DK6]: If you include a statement like this then maybe you can avoid citing Dugger et al. throughout the following sections.

Rate of Population Change

A primary goal of the large scale monitoring at the demographic study areas and the regular coordinated analysis of data is to monitor population trends of the Northern Spotted Owl through estimation of lambda (λ , defined as annual rate of population change; ~~Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016~~). A λ of 1.0 indicates that a population is stationary, whereas values greater or less than 1.0 indicate increasing or declining populations, respectively. Annual rates of population change (λ) were estimated for each of the eleven study areas using capture histories for 5,992 territorial owls, representing 29,520 total encounters of banded owls (Dugger et al. 2016). Estimates of the annual rates of population change indicated population declines of 1.2% to 8.4% per year, depending on the study area, with a weighted mean estimate indicating a range-wide decline of 3.8% per year from 1985-2013 (Table 7). This annual rate of decline is nearly 1% higher than the previous estimate for the same study areas from Forsman et al. (2011). These results suggest that Northern Spotted Owl populations have declined throughout the range of the subspecies, and the rate of decline is accelerating on many study areas.

There is strong evidence for declining populations on all three California study areas, including ~~at~~ HUP which was estimated to be stable ~~during through~~ the previous assessment ~~including covering~~ data through 2006 (Forsman et al. 2011). Prior to the start of Barred Owl removal experiments at GDR in 2009, the rates of decline at California study areas ranged from 1.2% to 3.9% per year. The inclusion of time trend covariates in the best models provide strong evidence that the rate of decline has been accelerating over time on all three California study areas (Dugger et al. 2016). A decline was also

observed just across the border in Oregon, where the Northern Spotted Owl population at the CAS study area has declined by an estimated 3.7% per year. Like the HUP study area in California, the population at the CAS study area in Oregon ~~was had been~~ stable through 2006 (Forsman et al. 2011).

Table 7. Trends in demographic parameters including fecundity, apparent survival, occupancy rates, and lambda (λ) for Northern Spotted Owls from 11 study areas in Washington, Oregon, and California, and estimates of mean lambda (λ) and percent population change, 1985–2013. Adapted from Table 25 in Dugger et al. (2016).

Study Area ¹	Trends				Estimates	
	Fecundity	Apparent Survival	Occupancy	Lambda (λ)	Lambda (λ)	Population Change ²
Washington						
CLE	Declining	Declining	Declining	No trend	0.916	-77%
RAI	No trend	Declining	Declining	No trend	0.953	-61%
OLY	No trend	No trend	Declining	No trend	0.961	-59%
Oregon						
COA	Declining	No trend	Declining	Declining	0.949	-64%
HJA	Declining	Declining	Declining	Declining	0.965	-47%
TYE	Declining	Declining	Declining	Declining	0.976	-31%
KLA	Declining	No Trend	Declining	Declining	0.972	-34%
CAS	No trend	Declining	Declining	No trend	0.963	-44%
California						
NWC	Declining	Declining	Declining	Declining	0.970	-55%
HUP	Declining	Declining	Declining	Declining	0.977	-32%
GDR-CB ³	Declining	Declining	Declining	Declining	0.988	-31%
GDR-TB ³	Declining	Declining	Declining	Declining	0.961	-26%
GDR-CA ³	**	**	Declining	**	0.878	-41%
GDR-TA ³	**	**	N/A	**	1.030	-9%

¹ See Table 6 for study area codes.

² With the exception of the GDR study area, percent population change through 2011.

³ GDR-TB = treatment areas before Barred Owls were removed; GDR-CB = control areas before Barred Owls were removed in treatment areas; GDR-TA = treatment areas after Barred Owls were removed (2009–2013); GDR-CA = control areas after Barred Owls removed in treatment areas (2009–2013).

** Too few years since Barred Owl removal to evaluate a trend.

Conversion of annual estimates of λ to estimates of realized population change allows for the portrayal of changes in population size over time relative to the population size in the initial year of study (Franklin et al. 2004, Dugger et al. 2016). These estimates show large declines in populations across the range, from 31% to 77% decline depending on study area (excluding Barred Owl removal areas). In California, population declines from the early 1990s through 2011 ranged from 31% to 55% for areas not receiving Barred Owl removal, with accelerated declines evident in recent years (Figure X). The Barred Owl treatment area on the GDR study area has had an increasing population of Northern Spotted Owls since removal of Barred Owls began in 2009, but still has an estimated overall decline of 9% since 1992. In contrast, the control areas on the GDR study area had the lowest rate of decline among areas prior to 2009 (1.2% annual rate of decline), but has had a much higher rate of decline since 2009 (12.2% annual

271 rate of decline). This annual rate corresponds to a population decline of 41% on the control area,
272 although confidence limits for λ are large and broadly overlap 1.0 due to the small number of years in
273 the post-treatment sample. The CAS study area in southern Oregon has experienced a population
274 decline of 44% since 1994.

275 Annual rates of decline and the realized population changes continue to be highest in Washington and
276 the COA study area of Oregon where Barred Owls have been well-established for a long time (Table 7).
277 However, population declines are now occurring on study areas in California that were experiencing
278 little decline or were stable through 2006, and the declines in California are accelerating ([Dugger et al.](#)
279 [2016](#)).

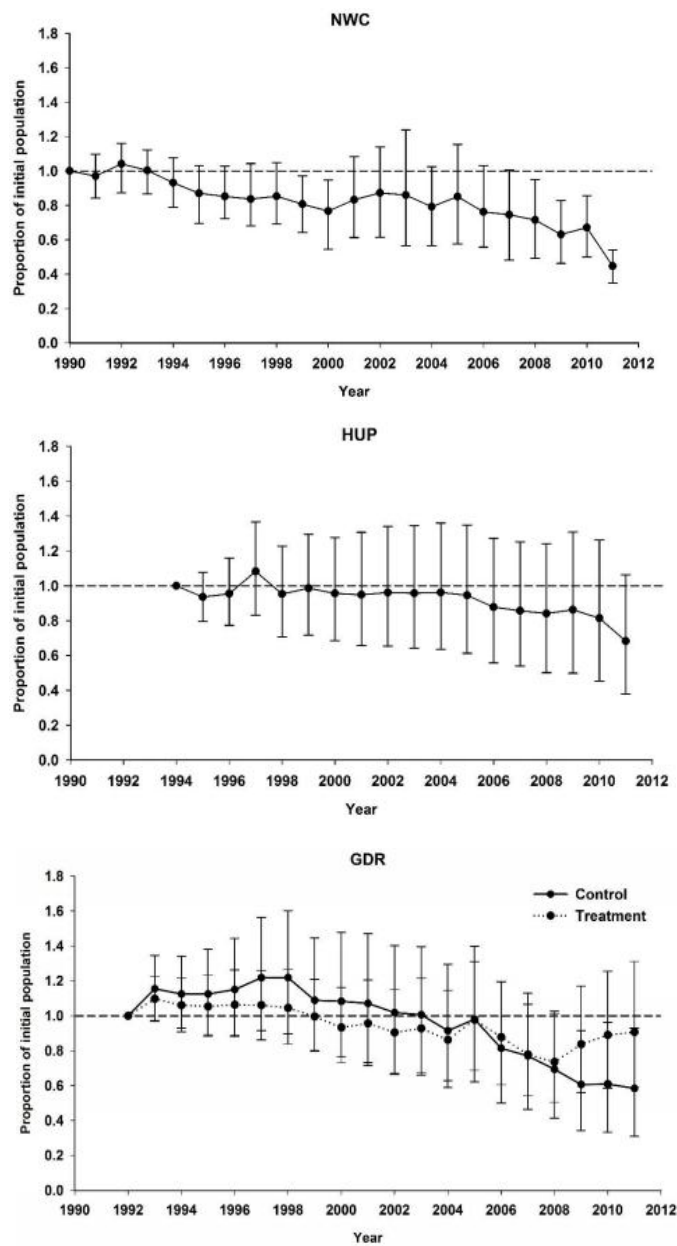


Figure X. Annual estimates of realized population change with 95% confidence intervals for Northern Spotted Owls at 3 study areas in California. Estimates for the GDR study area are presented separately for control and treatment areas in relation to Barred Owl removals beginning in 2009 (adapted from Figure 5 in Dugger et al. 2016).

285

286 *Fecundity*

287 Fecundity (i.e., number of female young produced per adult female) -was estimated using 12,969
288 records ~~of in which~~ the number of young produced by each territorial female per years was determined
289 (Dugger et al. 2016). Fecundity was influenced by the age of the female owl in all study areas, with mean
290 fecundity generally lowest for 1-yr-olds, intermediate for 2-yr-olds, and highest for adults (Dugger et al.
291 2016). Mean annual fecundity of adult females ranged between 0.22 and 0.34 (number of female young
292 produced per female per year) for most study areas with the HUP area in California having the lowest
293 annual fecundity (excluding GDR Barred Owl control and treatment areas that have data for only the
294 most recent five years) (Dugger et al. 2016). The Cle Elum study area in Washington was exceptional in
295 that it has had a much higher fecundity rate than other areas (0.57). The range-wide mean annual adult
296 fecundity was 0.31 for 1985-2013. This estimate of fecundity over a 29 year period was lower than any
297 previously reported meta-analysis estimate for Northern Spotted Owls (Anderson and Burnham 1992,
298 Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016).

299 Annual variation in fecundity is high for Northern Spotted Owls, due in part to the tendency to breed
300 only every other year (Figure Y for California study areas). High annual variation can make This may
301 make it more difficult to detect trends in fecundity relative compared to other vital rates that exhibit
302 less temporal process variation (Dugger et al. 2016). Nevertheless, model results provide evidence for
303 declining fecundity on all three study areas in California (Table 7; Dugger et al. 2016), with strong
304 evidence of decline at the NWC study area. There was little support for strong habitat associations with
305 fecundity on most study areas, however, more nesting and roosting habitat was associated with higher
306 fecundity at the NWC study area and more habitat in the territory core was associated with higher
307 fecundity at the GDR study area. Precipitation in the early nesting season was associated with a decline
308 in fecundity at the HUP study area.

309 Annual r reproductive rates have has also been reported for private timberlands outside of the
310 demographic study areas, although monitoring and analysis approaches are not standardized as in the
311 eleven 11 demographic study areas, so direct comparisons are not possible. Humboldt Redwood
312 Company (HRC 2013) reported noted a decline rep in reproductive rates since 2009 (citation). In the
313 coastal portion of the Northern Spotted Owl range in California, many areas reported consistently low
314 reproductive success from 2011-2013, including some of the lowest reproductive success rates on
315 record in 2013. These low reproductive rates were reported is is despite weather conditions in 2013 that
316 would typically support high good reproductive rates success. A similar results This was observed on
317 many timber company lands (Calforests 2014, HRC 2014, GDRC 2015), tribal lands (Higley and Mendia
318 2013), the NWC study area (Franklin et al. 2015), National Park Service lands (Ellis et al. 2013), and on
319 county-owned land in Marin County (Cormier 2013). During 2011, 2012 and 2013 HUP showed unusually
320 low reproductive rates of 0.05, 0.13, and 0.06, chicks fledged per pair, respectively. The reason for this
321 widespread pattern of low reproductive success is not known.

Comment [DK7]: So be precise here – do you mean “reproductive success” – which implies some measure of number fledged per number hatched or proportion of nests that hatched relative to total, or do you really mean “reproductive rates” or productivity, which is some measure of the number of young raised to fledging per breeding pair?

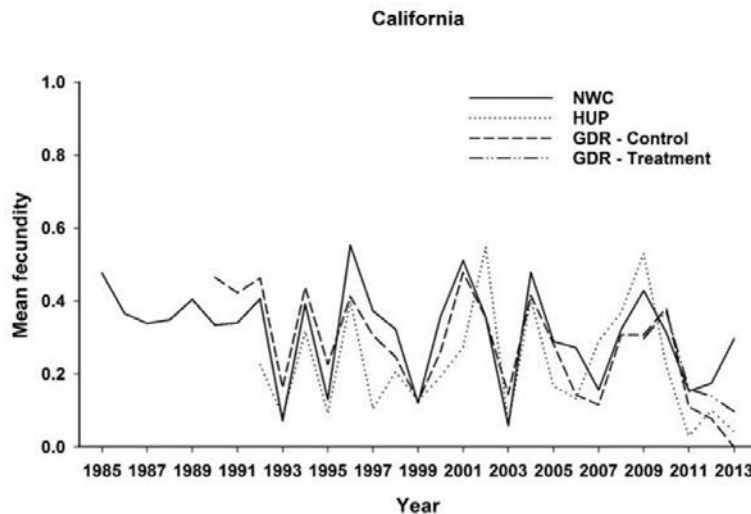


Figure Y. Annual fluctuations in mean fecundity (number of female young fledged per female) of Northern Spotted Owls in 3 study areas in California. Mean fecundity was graphed separately for the areas within the Green Diamond (GDR) study area where Barred Owls were removed (2009–2013; GDR-Treatment) and where Barred Owls were not removed (1990–2013; GDR-Control) (adapted from Figure 9 in Dugger et al. 2016).

Survival

The Northern Spotted Owl is a long-lived species, with relatively high annual adult survival rates. The encounter histories of 5,090 owls were used to estimate apparent survival in 11 individual study areas across 22–29 years (Dugger et al. 2016) using Cormack-Jolly-Seber open population models and mark-resighting data (Lebreton et al. 1992). Apparent annual survival rate represents the probability that a bird that was alive in one year will be alive and present on the study area the following year, therefore a mean rate of 1.0 would indicate that all birds survive from one year to the next. Mean estimates of apparent survival ranged from a low of 0.835 ± 0.020 on Rainier (RAI) to a high of 0.870 ± 0.009 on HJA and 0.870 ± 0.021 on GDR treatment areas after barred owl removals began (Table 17 in Dugger et al. 2016). There was strong support for declining apparent survival in at least 8 of 11 study areas, including all three California study areas and the CAS study area in southern Oregon (Table 7). These declines in apparent survival are concerning because adult survival is the most important vital rate influencing the rate of population change in long-lived birds and Forsman et al. (2011) found that for most demographic study areas, changes in λ were driven mainly by changes in survival in Northern Spotted Owls. Franklin et al. (2000) argued that annual survival, which exhibited little annual variation, served as the baseline for λ while recruitment accounted for most of the annual variation in λ .

Comment [DK8]: Put study areas in here.

The best survival models that included the ~~negative~~ effect of Barred Owl detections found support for a negative effect of Barred Owl ~~present~~ on apparent survival of Spotted Owls in 10 of 11 study areas (Dugger et al. 2016). ~~In addition,~~ Survival rates in the GDR study area were higher in treatment areas after Barred Owl removals began in 2009, ~~increasing~~ from 0.857 ± 0.009 before Barred Owl removals ~~began~~ to a high of 0.870 ± 0.021 after ~~Barred Owl removals began~~. Conversely, the GDR control areas that did not experience Barred Owl removal saw a decline in survival rates during the same time period from 0.858 ± 0.008 to a low of 0.804 ± 0.032 (Dugger et al. 2016).

~~Local weather and regional c~~limate covariates occurred in top or competitive survival models for 10 of 11 study areas and in most cases the relationships were as predicted, but there was little consistency among areas as to which ~~specific~~ covariate was important. Increased precipitation during the early nesting period was associated with decreased survival rates at NWC and higher temperatures during the early nesting season were associated with higher survival at GDR. The meta-analysis which included evaluation of all study areas combined showed that adult apparent survival was higher when PDO was in a warming phase and lower when the SOI was negative (negative SOI's indicate El Nino events). That is, higher adult apparent survival was observed when winters were warm and dry (positive association with PDO and negative association with SOI) (Dugger et al. 2016).

In California, all three study areas in the recent analysis were shown to be experiencing declines in both fecundity and survival (Dugger et al. 2016). The previous two meta-analyses which analyzed data collected through 2004~~3~~ and ~~2008~~2009, respectively, found evidence of declining fecundity on two California study areas ~~but found evidence for and~~ declining survival on ~~only~~ one (Anthony et al. 2006) or two ~~areas~~ (Forsman et al. 2011). Therefore declines in fecundity and survival in the California portion of the range have become more widespread in the last decade. Results from the recent analysis indicated that declines in apparent annual survival in the California portion of the range of the Northern Spotted Owl may be reaching rates of decline previously observed only in Washington (Dugger et al. 2016). The overall assessment is that reproduction and recruitment from outside the study areas have not been sufficient to balance losses due to mortality and emigration, so the populations on study areas have declined over the 22-29 years included in the study.

Occupancy

Occupancy data are less resource-intensive to collect compared to ~~the banding and resighting~~ data required to estimate the demographic parameters discussed above. Estimation of survival and reproduction requires the capturing and banding of owls at known sites, and multiple annual visits to all sites in order to ~~monitor survival and recapture or re-sight owls and to determine~~ reproductive status from individually identifiable owls. Occupancy data is based on the presence or absence of owls from known sites, ~~but individual owl histories are not required,~~ and ~~depending on the objectives of the monitoring does not necessarily require~~ the monitoring of all sites each year ~~is not required (i.e., "missing data" is allowed)~~, although multiple visits per site ~~within years~~ are required in order to estimate detection probability. Due to the reduced requirement in survey effort and the ~~necessity-need~~ to visit

known owl sites during pre-timber harvest monitoring, presence-absence data has frequently been collected and reported by timber companies and by other landowners (e.g. National Parks) [\(citations?\)](#).

In order for estimates of occupancy to be valid, survey efforts must be consistent over time and the detection probability (the probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead to high variation in detection probability which can bias estimates of occupancy and other vital rates [if not accounted for in the modeling process](#). Occupancy estimation also assumes that the occupancy state at sites is closed [within years](#) and that sites are independent; in other words, occupancy does not change at a site within a season and detection of the target species at one site is independent of detecting the species at other sites (MacKenzie et al. 2006). [Ideally the owl population being evaluated for occupancy rate would be banded in order to address a concern of inflated occupancy rates in areas where Barred Owl presence may increase movement of Spotted Owls.](#) Higley and Mendia (2013) observed banded Northern Spotted Owls in more than one territory per season and movement of up to several miles, and suggested that this may result in an inflated occupancy rate on the Hoopa Valley Indian Reservation. [If owls are not color banded, it may be difficult to interpret trends in occupancy rates because of potential violations of the assumptions of population closure and independent sites.](#) Higley and Mendia (2013) believe that inflation of observed occupancy rates may be more likely in areas where Barred Owls are present and displace Spotted Owls. [In areas where the owl population is not marked with color bands, this issue might be resolved if movement is better understood. For example, if the movement occurs over long time periods or during specific seasons it might be able to be accounted for in the sampling design \(MacKenzie et al. 2006\).](#)

In the recent meta-analysis of data from the 11 demographic study areas, territory occupancy dynamics were modeled on each study area with strong declines in estimates of occupancy observed at all 11 study areas since the 1990s (Dugger et al. 2016). In California, occupancy rates declined [by up to 49%, with the occupancy rate for at NWC declining from 79% to 47%, at HUP from 74% to 38% at HUP, and at GDR control areas from 92% to 55% on control areas for GDR \(Dugger et al. 2016\).](#) [In addition, the declines in occupancy rates have been accelerating at NWC and HUP \(Figure Z\), although the occupancy rate has increased on at the GDR treatment areas following removal of Barred Owls \(Dugger et al. 2016\), which has slowed the overall decline in occupancy at the GDR study area.](#) In the Cascades of southern Oregon, the occupancy rate declined 36% (from 69% to 44%) at the CAS study area and the decline has [also been accelerating since the last meta-analysis](#).

[Patterns in site occupancy are achieved through two processes: colonization of previously unoccupied sites, and local extinction of previous occupied sites \(MacKenzie et al. 2003, 2006\).](#) Thus, the annual ~~the~~ probability of site occupancy [can be derived from estimates of initial site occupancy \(from 1st year of study\), and subsequent estimates of annual site colonization rate and the local extinction rates \(MacKenzie et al. 2003\).](#) [Based on analyses using multi-season occupancy models that explicitly modeled the occupancy dynamics of both Barred Owls and Spotted Owls on historic Spotted Owl territories \(Richmond et al. 2010\), the most consistent pattern in occupancy dynamics from the recent meta-analysis was the strong positive association between the presence of Barred Owl and territory extinction rates across, with all 11 study areas exhibiting this strong relationship \(Figure XX; Dugger et al. 2016\).](#)

Comment [DK9]: But, as long as multiple visits are made to each site each year, you can account for survey effort variation pretty easily. The problem is if sites are only visited once multiple years in a row, as while "some" missing data is OK, lots is not.

Comment [DK10]: Actually, this isn't exactly true as suggested here. Estimates of occupancy (probability that a site is occupied or not) are not biased by "movements" of NSO between territories as long as it's occurring between survey seasons (i.e., occupancy status of territories is stable during the survey season). If it's occurring within a season, then yes, it's possible occupancy rates are "inflated" as birds can be detected on a territory but not remain to reproduce if BO are shoving them around (i.e., the same bird can be recorded on multiple territories within the same season). However, having birds banded doesn't necessarily alleviate the problem, particularly if "detections" include single birds responding to night surveys, (i.e., no opportunity to observe bands). Probably the best way to avoid these problem is to estimate "pair occupancy" rather than occupancy by any bird (single, or otherwise) – and that is what most of the peer-reviewed journal publications detailing occupancy rates for NSO actually estimate (sometimes single too, but "the pair" is generally considered the ecological unit of interest). By estimating occupancy rates of pairs within a season, you at least avoid documenting "presence" of transients who may be moving around each year.

That said, information gained from banded birds can be really important, as just because a site is "occupied", even by a pair, that doesn't mean the occupants are surviving or breeding (could be high turnover between years and birds on a site aren't actually producing young). So monitoring reproductive status for pairs on occupied sites can be very important too.

Comment [DK11]: See previous comment – I think this is a report right? Be careful about citing non-peer-reviewed data. Also be clear whether authors are talking about occupancy by any owl, or occupancy by pairs, as I don't think these statements are true for estimates of pair occupancy.

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Increased occupancy rates of spotted owl territories by Barred Owls were associated with increased extinction rates of Northern Spotted Owls at these same territories. These results are is-pattern-is consistent with previous analyses documenting the negative reports on the effect of Barred Owl detections or occupancy rates on Northern Spotted Owl extinction rates (Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011, Davis et al. 2013, Yackulic et al. 2012, 2014). In addition, Barred Owls had a negative effect on site colonization rates at 5 of 11 study areas in the meta-analysis, but this effect was not apparent in California (Figure XX; Dugger et al. 2016). The effect of Barred Owl on local extinction and colonization is evident in the extremely low occupancy rates seen at demographic study areas in Washington where the Barred Owl has been established for a longer time period, with occupancy rates at all Washington study areas below 25% and as low as 11% at the Cle Elum study area (Dugger et al. 2016).

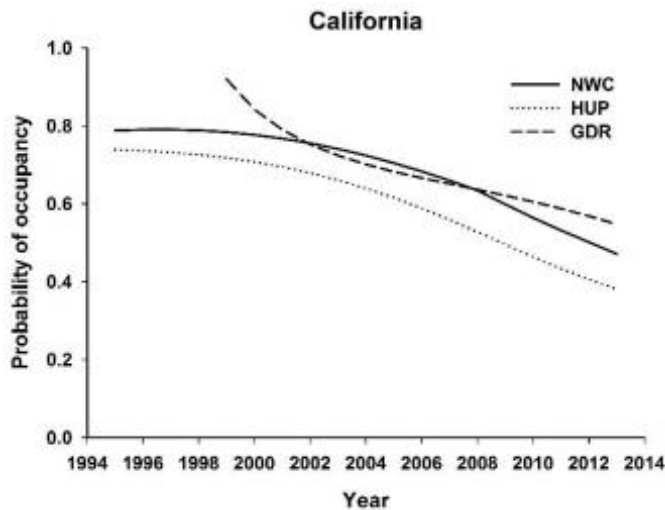


Figure Z. Estimates of the probability of territory occupancy for Northern Spotted Owls on three study areas in California (adapted from Figure 8 in Dugger et al. 2016).

The total amount of suitable owl habitat had a strong positive association with colonization rates at five study areas, including NWC (Dugger et al. 2016). Habitat covariates were also associated with extinction rates at 8 of 11 study areas with more suitable habitat at Northern Spotted Owl territories associated with decreased rates of extinction (Dugger et al. 2016). At NWC the total amount of suitable habitat in owl territories was positively associated with colonization rate and the amount of nesting and roosting habitat in the territory core was negatively associated with extinction rate, highlighting-suggesting the importance of habitat at maintaining site occupancy in the Klamath physiographic province in California.

Declining occupancy rates must be considered when interpreting results of the demographic analysis of other vital rates because estimates of fecundity and survival rates are independent of population size.

444 The estimated rates of fecundity and survival are per capita averages across all owls in a study area and
445 so do not incorporate any direct measure of population size. If a study area experiences a declining
446 number of territorial owls, which on average are experiencing reductions in rates of fecundity, the result
447 will be far fewer owls produced each year. Even if Northern Spotted Owls at a given study area
448 experience stable rates of fecundity over time, areas with declining occupancy rates will produce fewer
449 young overall. Information on rates of survival and fecundity provide a clearer picture of potential
450 mechanisms for population declines (i.e., determination of vital rates that are contributing most to the
451 population declines and factors influencing those rates), but must be considered in association with the
452 number of territorial owls and the factors that drive occupancy rate in order to understand the broader
453 impact to a population.

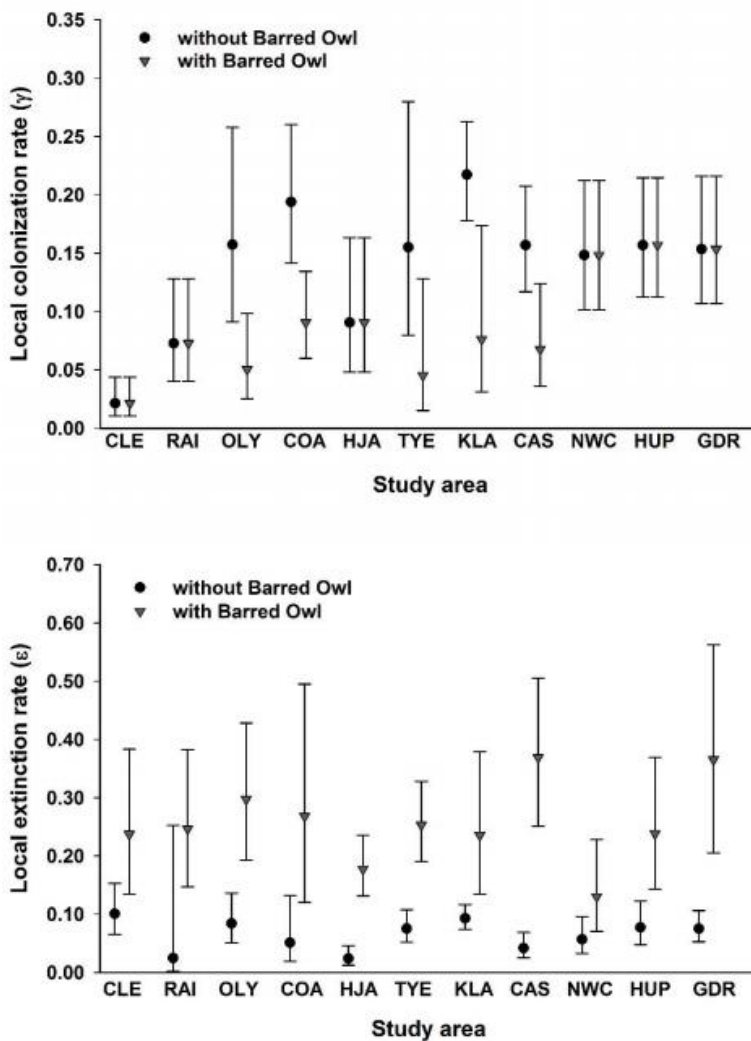


Figure XX. Mean local colonization and extinction rates with 95% confidence limits for Northern Spotted Owls on 11 study areas in Washington, Oregon, and California when Barred Owls are present (gray triangles) or absent (black circles) (adapted from Figure 7 in Dugger et al. 2016).

As examples of declining populations at California demographic study areas, the number of owls observed-detected between 1992 and 2006 at HUP was between 60-70 owls each year; a steep decline since then has resulted in only 30 owls observed-detected in 2013 (Higley and Mendia 2013). At the GDR

Comment [DK12]: Need to be careful with this kind of data. Number of owls detected each year does not account for detection rates <1.0. The number detected could still be a good "index" if those annual detection rates were "equal" across years, but we know that because of BO, that isn't true – detection rates of NSO have generally declined over time..... So the # detected always underestimates the true population size when detection rates are <1.0, and since detection rates have "changed" over time, you can't really use these estimates to index relative population change.

462 density study area, the number of occupied sites declined from about 120-140 sites for years 1992-2004
463 to just over 80 occupied sites in 2008 (GDRC 2015). A partial recovery in number of occupied sites led to
464 about 110 occupied sites by 2012; the authors attributed this increase to removal of Barred Owls and an
465 increase in suitable habitat (GDRC 2015).

466 Although occupancy will often reflect changes in local population size and can provide an alternative to
467 the estimated rate of population change in assessing population status, it is not always appropriate to
468 use an apparently stable occupancy rate to suggest a stable population size. Forsman et al. (1996) makes
469 the following statement regarding occupancy and population declines:

470 “...it is possible that in a declining population, observed densities of territorial owls might not
471 change during early years of the decline simply because territorial owls that died could be
472 replaced by floaters (owls without territories) (Franklin 1992). Thus, significant changes in
473 density of territorial owls might not become apparent for many years, especially if the rate of
474 population decline was small (e.g., 1-2% per year).”

475 Therefore, a lack of a significant decline in observed owl numbers over the short-term might not reflect
476 vital rates in the local population. Although little is known about the floater population of Northern
477 Spotted Owls at any study area, other than that they exist and that they do not readily reply to
478 broadcast calling, the number of floaters is finite. The perception of population stability due to
479 establishment of territories by floaters cannot continue indefinitely in a constantly shrinking population.
480 ~~Depending on the~~ The annual rate of population decline (λ) ~~will actually increase, the phenomenon should~~
481 ~~gradually disappear~~ as the floater population is depleted, ~~because recruitment must then come entirely~~
482 ~~from continued, annual production of young~~. If a study area has a relatively robust population of
483 floaters, or if emigration into the study area occurs, the total local population can decline for some time
484 before ~~being detected through~~ declines in territory occupancy are observed. Although declines in
485 occupancy can indicate a reduction in local abundance when survey efforts are consistent over time
486 (Bigley and Franklin 2004), a stable occupancy rate may not necessarily indicate that a local population is
487 stable, ~~so estimates of survival and fecundity are also important for assessing the overall status of a~~
488 ~~population~~.

489 Outside of the three California demographic study areas, studies that have compiled robust datasets
490 suitable for evaluation of Spotted Owl site occupancy in California are rare. In the southern Cascades
491 and interior Klamath provinces of California where there are no demographic study areas, Farber and
492 Kroll (2012) compiled presence-absence data from 1995-2009 at 63 Northern Spotted Owl sites located
493 within a checkerboard landscape (intermixed federal and private ownership). Occupancy modeling
494 showed that ~~simple and pair~~ Spotted Owl occupancy probabilities ~~for both any detected owl (single or a~~
495 ~~pair) and pairs~~, declined approximately 40% over the 15 year period (Farber and Kroll 2012). ~~Site~~
496 occupancy for any owl declined from 0.81 (0.59-0.93) to 0.50 (0.39-0.60), and pair occupancy declined
497 from 0.75 (0.56-0.87) to 0.46 (0.31-0.61). These results from private timberlands are consistent with the
498 declines observed on federal lands to the north at the CAS study area in southern Oregon (Dugger et al.
499 2016). Although estimates of occupancy rate are not available, Northern Spotted Owls appear to have
500 been nearly extirpated from the 97,000 acre Redwood National and State Parks on the northern

Comment [DK13]: Similar comment to above – if these are “naïve” or “apparent” estimates of occupancy (i.e., proportion of sites where NSO were detected each year relative to total number surveyed) without accounting for detection rates <1.0, you can’t compare these numbers to the occupancy rates from Dugger et al. 2011, 2016, Kroll et al. 2010, etc. – and these estimates of “naïve” occupancy are negatively biased (because detection rates <1.0, occupied sites are “misclassified” when NSO aren’t detected during surveys even though they may be present). Because of multiple surveys within a season, this “bias” for occupancy at least is probably relatively low (cumulative detection rates from multiple visits within a season can be >0.70), but it’s still important to make a distinction between this kind of data and estimates based on models that account for detection rates.

501 California coast in Del Norte and Humboldt counties. Forty Northern Spotted Owl activity centers were
502 identified in the parks during the 1990s but most of these sites appear to are now be occupied by Barred
503 Owls only (Schmidt 2013). Only four Northern Spotted Owls were detected in these National P-parks
504 during 2013-2014, with only one pair observed; the last Northern Spotted Owl fledgling juvenile known
505 to have been produced in the parks was reported in 2010 (Schmidt 2015). At the extreme southern edge
506 of the Northern Spotted Owl range in Marin County, recent surveys of 30 historical Spotted Owl sites
507 using the USFWS protocol have shown that naïve estimates of pair occupancy remained high at about
508 90% (Cormier 2013). Interestingly, this is a portion of the range where Barred Owls remain relatively
509 uncommon.

Comment [DK14]: Unclear what "juvenile" means. Do you mean "subadult" (1 or 2 year old) seen in 2010 that was known to have been produced in the park in a previous year, or do you mean young of the year, actually produced in the park during 2010?

510 The Department evaluated occupancy data and results provided by nine private timber management
511 companies (Calforests 2014). In contrast to the above studies at demographic study areas and at other
512 well-monitored areas that showed modeled declines in occupancy or displacement of Northern Spotted
513 Owls, five of nine companies reported a stable trend in occupancy with one company reporting that the
514 population size is variable. Two companies reported a mix of stable, declining, or increasing occupancy,
515 depending on the time period, the method used to estimate occupancy rate, or the portion of the owl
516 population assessed (Calforests 2014). However, several issues with the survey methods or analyses are
517 apparent. In at least two cases the samples appear biased due to surveying only the best sites every year
518 or excluding sites where Barred Owl had been detected. In several cases survey methods varied from
519 site to site, or from year to year. In most cases the companies have reported on counts of occupied sites
520 or on naïve estimates of occupancy (the proportion of surveyed sites that are occupied in a given year)
521 without consideration of detection probability. (citations?). Counts of occupied sites and detection
522 probability are both dependent on survey effort and survey effort was not always reported. An example
523 of this can be seen in data submitted by Mendocino Redwood Company, which shows a positive
524 correlation between survey effort and estimates of occupancy (citations?). In several cases, the level of
525 detail at which methods are described does not allow for evaluation of occupancy estimates.

Comment [DK15]: Is this all from "calforests 2014?"

526 The variability in survey methods used, reports of counts or naïve estimates of occupancy without
527 consideration of detection probability, the sometimes inconsistent or biased methods used over time,
528 and the limited description of methods results in little support for the conclusion by from some timber
529 companies that occupancy rates have been stable over time.

530 However, three timber companies reported results of occupancy modeling that incorporated estimates
531 of detection probability. Of these, the Green Diamond Resource Company has participated in the large
532 demographic study since 1990 and the large declines in occupancy at the study area are reported above.
533 The Mendocino Redwood Company reported a slight decline in occupancy rates based on modeling of
534 data collected for a subset of years from 2001-2008, but no estimate of occupancy rate was presented
535 for more recent years during which the local Barred Owl population has increased dramatically (MRC
536 2014). Campbell Global, L.L.C. manages timber lands for multiple owners, and reported on occupancy
537 rates for two ownerships in Mendocino County (Calforests 2014). Occupancy dynamics were modeled
538 using data from 1990-2010 for these Mendocino County ownerships and occupancy probabilities for
539 single Northern Spotted Owls began to decline in 2003, while and pair occupancy rates declined by 16-
540 30% during the initial portion of the time period before stabilizing in 1997. In each of these cases the

Comment [DK16]: Isn't this site one of the few with almost no BO? At least until very recently?

541 results of occupancy modeling demonstrated evidence of declining occupancy rates, providing
542 additional evidence of declining occupancy in the California Coast province.

Summary of Listing Factors

Abundance and Demographic Rates

There are no reliable range-wide estimates of Northern Spotted Owl population abundance because there is no sampling method that effectively detects all owls in a given area. There are 3,116 known Northern Spotted Owl activity centers in California, but the number of these sites occupied in any year is unknown, ~~and~~ so this number represents the cumulative number of territories recorded over time in a dynamic landscape rather than an index of abundance. The immense amount of data available on Northern Spotted Owl habitat requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity, dispersal behavior, and impacts of Barred Owls on survival, were used to model source-sink dynamics across the range of the owl and to simulate an estimate of population size (Schumaker et al. 2014). Simulations produced a range-wide population size of about 3,400 female Northern Spotted Owls, with about half of these occurring in California. However, the complexity of the model and its reliance on incomplete data limits its ability to accurately model population estimates, as demonstrated by its inability to correctly simulate the number of owls in some areas of known population size.

Comment [DK1]: Well, are there really areas with "known" population size? I think we can say there are areas where historic territory occupancy rates are known.....

A huge effort to monitor the effectiveness of the Northwest Forest Plan has resulted in an enormous amount of data on the demographics of Northern Spotted Owl populations. These data have been collected over more than two decades at study areas covering a large portion of the Northern Spotted Owl range from Washington to California, and represent a mix of federal, private, and tribal lands (Dugger et al. 2016). The data likely represent the best population demographic information on an endangered species ever assembled (Gutiérrez 2008) and allow for estimation of population vital rates across a large portion of the Northern Spotted Owl range. Vital rates have been evaluated on each of 11 individual study areas and ~~also using~~ data from all study areas ~~was~~ combined for a range-wide assessment of population status and trends (meta-analysis) (Dugger et al. 2016). Population parameters estimated include ~~the annual~~ rate of population changes, survival, fecundity, recruitment, ~~and~~ site occupancy, ~~and occupancy dynamics (colonization and local extinction rates) rates.~~

Northern Spotted Owl populations are declining throughout the range of the subspecies and annual rates of decline have been accelerating in many areas, including in California. The range-wide population of Northern Spotted owls is estimated to have declined by 3.8% per year since 1985 (Dugger et al. 2016). ~~On all three study areas in California, Every~~ vital rates ~~estimated from these long-term datasets, including fecundity, survival, site occupancy, and rate of population change, are is declining at all three California demographic study areas,~~ and the rates of population decline ~~have~~ accelerated in recent years ~~on at all three California study~~ areas. In addition to the declines observed at these study areas in the California Coast and Klamath provinces, an independent study of occupancy that includes private timberlands in the California Cascades province has shown declines in occupancy (Farber and Kroll 2012), and a study area just across the border in Oregon has shown that populations in the southern

Cascades have experienced declines in population size, occupancy rate, and survival (Dugger et al. 2016).

Together these results reveal severe declines in the Northern Spotted Owl population throughout much of its range in California. Causes of population declines have included reductions in recruitment into the breeding population (including fecundity) and reductions in apparent survival, both of which have been declining on all California study areas. In recent years the declines in vital rates and populations in California have deteriorated to levels previously restricted to more northerly portions of the subspecies range in Washington and Oregon. With the exception of the Green Diamond Resource Company treatment areas where Barred Owls have been removed, the population sizes at California study areas have declined 31-55% since the 1990s (Dugger et al. 2016). The rates of site occupancy at known territories in California study areas and in additional areas in the Cascades have declined dramatically, with 39-49% declines in occupied sites since 1995. These severe and accelerating declines put the Northern Spotted Owl at risk of becoming extinct in all or a significant portion of its range, including the portion of its range in California which until recently was experiencing relatively minor declines.

Although many factors have contributed to these declines, the best evidence suggests that increasing numbers of Barred Owls in California have had a strong impact in recent years, primarily by decreasing apparent survival and increasing local territory extinction rates ([Dugger et al. 2016](#)). However, the amount of suitable owl habitat, local weather, and regional climatic patterns also effected survival, occupancy, recruitment, and fecundity. The ongoing and increasing effects of Barred Owls on Northern Spotted Owl populations, coupled with other threats including habitat loss due to timber harvest and wildfire and reduced recruitment due to climate change, will lead to additional declines in Spotted Owl populations unless additional management intervention is undertaken.

Comments from Alan B. Franklin, Ph.D.

From: [Franklin, Alan B - APHIS](#)
To: [Clipperton, Neil@Wildlife](#)
Cc: [Battistone, Carie@Wildlife](#)
Subject: RE: Northern Spotted Owl Status Review - External Peer Review
Date: Wednesday, November 25, 2015 4:19:27 PM
Attachments: [image004.jpg](#)
[image005.jpg](#)
[CDFG NSO Status Review - Peer Review \(Franklin\) General Comments.pdf](#)
[CDFG NSO Status Review - Peer Review \(Franklin\) Track Change Comments.docx](#)

Neil and Carie,

Attached is my review Department of Fish and Wildlife's draft Status Report on the Northern Spotted Owl in two parts:

1. My general comments in the attached file: CDFG NSO Status Review - Peer Review (Franklin) General Comments.pdf
2. More specific comments using Track Changes in the attached file: CDFG NSO Status Review - Peer Review (Franklin) Track Change Comments.docx

I suggested adding some additional literature, some of which were theses and reports. If you need electronic copies of these, let me know and I can send them.

Hope this helps and have a good Thanksgiving,

Alan

Alan B. Franklin, Ph.D.
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From: Clipperton, Neil@Wildlife [mailto:Neil.Clipperton@wildlife.ca.gov]
Sent: Tuesday, September 08, 2015 6:34 PM
To: Franklin, Alan B - APHIS
Cc: Battistone, Carie@Wildlife
Subject: RE: Northern Spotted Owl Status Review - External Peer Review

Hello Dr. Franklin,

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's draft Status Report on the Northern Spotted Owl.

Please see the attached for a signed transmittal memo and a copy of the report, dated September 8,

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
NORTHERN SPOTTED OWL
(*Strix occidentalis caurina*) IN CALIFORNIA



CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
EXTERNAL REVIEW DRAFT, September 8, 2015



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Comment [A1]: Note to external reviewers:
These appendices will be added later.

Acknowledgments (to be completed after external review)

This report was prepared by: Neil Clipperton and Carie Battistone

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EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: September 8, 2015

**Report to the Fish and Game Commission
A Status Review of the Northern Spotted Owl in California
EXTERNAL REVIEW DRAFT, September 8, 2015**

Executive Summary

[TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]

Regulatory Framework

Petition Evaluation Process

A petition to list the Northern Spotted Owl as threatened or endangered under the California Endangered Species Act (CESA) was submitted to the Fish and Game Commission (Commission) on September 7, 2012 by the Environmental Protection Information Center. A petition evaluation report was prepared by the Department of Fish and Wildlife (Department) and submitted on February 14, 2013, to assist the Commission in making a determination as to whether the petitioned action may be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & (e)).

The Department's charge and focus in its advisory capacity to the Commission is scientific. A petition to list or delist a species under CESA must include "information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The Petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and other factors the Petitioner deems relevant" (Fish & G. Code, § 2072.3). Given this charge the Department recommended to the Commission that the petition be accepted.

Status Review Overview

The Commission published findings of its decision to advance the species to candidacy on December 27, 2013, triggering a 12-month period during which the Department conducted a status review to inform the Commission's decision on whether to list the species. Per Fish & G. Code, section 2074.6, the Department requested a 6-month extension, to allow further analysis and evaluation of the available science, completion of the status review, and peer review process. Due to the extension, Department had a total of 18 months from December 27, 2013 to deliver the status review to the Commission.

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This written status review report indicates, based upon the best scientific information available, whether the petitioned action is warranted, preliminary identifies habitat that may be essential to the continued existence of the species, and recommends management activities and other recommendations for recovery of the species (Fish & G. Code, § 2074.6). Receipt of this report is to be placed on the agenda for the next available meeting of the Commission after delivery. At that time, the report will be made available to the public for a 30-day public comment period prior to the Commission taking any action on the Department’s recommendation.

Existing Regulatory Status

Endangered Species Act

The U.S. Fish and Wildlife Service listed the Northern Spotted Owl as threatened under the Endangered Species Act in 1990. Critical habitat designation occurred in 1992 and was revised in 2008, and a new final rule designating critical habitat was published in December 2012. The first final recovery plan for the Spotted Owl was issued in 2008 and revised in 2011.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act prohibits anyone from taking, killing, or keeping any native bird, its parts, or its nest, without a permit or license. All raptors native to the U.S. are covered by this law. A Special Purpose Possession Permit and/or Endangered Species Permit (depending on species), is required under the Migratory Bird Treaty Act to keep raptors.

California Endangered Species Act

After the Commission voted to accept the petition in December, 2013, the Northern Spotted Owl became a State candidate for threatened or endangered status under the California Endangered Species Act, commencing with section 2050 of the California Fish and Game Code

California Bird Species of Special Concern

The Department currently designates the Northern Spotted Owl as a Species of Special Concern.

Fish and Game Code

The Fish and Game Code includes certain protections for raptors, including the Northern Spotted Owl. Sections applicable to owls include the following:

Section 3503 - It is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.

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298 Section 3503.5 - It is unlawful to take, possess, or destroy any birds in the orders Falconiformes
299 or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird
300 except as otherwise provided by this code or any regulation adopted pursuant thereto.

301 Section 3513 - It is unlawful to take or possess any migratory nongame bird as designated in the
302 Migratory Bird Treaty Act or any part of such migratory nongame bird except as provided by
303 rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory
304 Treaty Act.

305 *California Board of Forestry and Fire Protection*

306 The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire
307 Protection (CAL FIRE) have designated Northern Spotted Owl as a "Sensitive Species" as identified in the
308 California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules).
309 These sections also define Northern Spotted Owl -related terminology, including "activity center",
310 "Northern Spotted Owl breeding season", and "Northern Spotted Owl Evaluation Area." Specific
311 requirements for the disclosure of information on Northern Spotted Owls in the context of timber
312 harvesting, which in all but one case avoid take of Northern Spotted Owl are provided by Forest Practice
313 Rules sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted
314 Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by
315 CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and
316 related activities, would be avoided according to the criteria for determining take avoidance found in
317 Section 919.10. Other language within Section 919 also compels methods to avoid take of Northern
318 Spotted Owl. Sections 919.2 and 919.3 set up protections of bird nests through buffers and avoidance of
319 sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the
320 protections afforded to late successional forests, which are a component of Northern Spotted Owl
321 habitat.

322 *International Union for Conservation of Nature*

323 The International Union for Conservation of Nature Red List of Threatened Species status for the
324 Spotted Owl range-wide is "Near Threatened" because the "species has a moderately small population
325 which continues to decline in northern and western parts of its range."

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Biology and Ecology of the Northern Spotted Owl

Life History

Species Description

The Northern Spotted Owl is a medium-sized dark brown owl, with a barred tail, white spots on its head and breast, and dark brown eyes surrounded by prominent facial disks (Forsman et al. 1993, Gutiérrez et al. 1995). Overall, its length is approximately 46 to 48 centimeters (18 to 19 inches) (Forsman et al. 1993). Males and females are dimorphic in size, with males averaging about 13 percent smaller than females (USFWS 2011a). Males weigh between 430 to 690 grams (0.95 pound to 1.52 pounds), and females weigh between 490 to 885 grams (1.1 pounds to 1.95 pounds) (P. Loschl and E. Forsman pers. comm. 2006 in USFWS 2011a). The Northern Spotted Owl resembles the Barred Owl in appearance, and first generation hybrids of the two species exhibit physical and vocal characteristics of both (Hamer et al. 1994, Kelly and Forsman 2004).

Comment [ABF2]: Should also cite Gutiérrez et al. 1995.

Taxonomy and Genetics

The American Ornithologists' Union recognizes the Northern Spotted Owl as one of three subspecies of Spotted Owls. The two other subspecies are the California Spotted Owl (*S. o. occidentalis*), ranging in the southern Cascade Range of northern California south along the west slope of the Sierra Nevada and in mountains of central and southern California, and Mexican Spotted Owl (*S. o. lucida*) ranging from southern Utah and Colorado south to Michoacán, Mexico. The taxonomic separation of these three subspecies is supported by genetic, morphological, and biogeographic information (Barrowclough and Gutiérrez 1990, Gutiérrez et al. 1995, Haig et al. 2004a, Chi et al. 2005, Henke et al. 2005, Barrowclough et al. 2005, Funk et al. 2008, AOU 2011, Barrowclough et al. 2011). The Marin County population of Northern Spotted Owl is genetically isolated from other Spotted Owl populations in California (Jenson et al. 2006).

Comment [ABF3]: I would include Barrowclough, G. F., J. G. Groth, L. A. Mertz, and R. J. Gutiérrez. 2005. Genetic structure, introgression, and a narrow hybrid zone between northern and California spotted owls (*Strix occidentalis*). *Molecular Ecology* 14:1109-1120. As the primary reference here.

There is a narrow, apparently stable zone where hybridization occurs between the Northern and California Spotted Owl in the Southern Cascades and Northern Sierra Nevada Mountains near the Pit River in California (Courtney et al. 2004, Barrowclough et al. 2005). There is evidence in all genetic studies conducted on the species of some genetic mixing of California Spotted Owl into the Northern Spotted Owl range, and fewer examples of the opposite (Courtney et al. 2004). In the Klamath region of California 20.3% of owls were classified as California Spotted Owls (Haig et al. 2004a). Among all Northern Spotted Owls sampled across their range in Oregon, Washington, and California, 12.9% contained California Spotted Owl haplotypes (Haig et al. 2004a). There has been some evidence for genetic flow between Mexican Spotted Owls and Northern Spotted Owls, primarily in Washington, indicating long-distance dispersal of Mexican Spotted Owls most likely via the Rocky Mountain dispersal route (Funk et al. 2008). Until recently, there has been little evidence in the literature of loss of genetic variation and population bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across the range of the Northern Spotted Owl (Washington Cascade Mountains,

Comment [ABF4]: I would check this statement with Rocky Gutierrez or George Barrowclough. This seemed very unusual given their previous work on spotted owl genetics

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Oregon Cascade Mountains, Oregon Coast Ranges, and Klamath Mountains of Oregon and California) provides compelling evidence that a population bottleneck may have occurred, with more prominent bottlenecks in the Washington Cascade Mountains as compared to other regions in the analysis (Funk et al. 2010).

Since the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two species have resulted as well. The majority of hybrids that have been evaluated with genetic methods have resulted from a cross between a female Barred Owl and a male Spotted Owl (Haig et al 2004b, Kelly and Forsman 2004). First generation hybrids share phenotypic and vocal characteristics of both parent species (Hamer et al. 1994). Second generation hybrids are often difficult to distinguish from Barred or Spotted Owls in the field and genetic testing may be the only sure method of identification (Kelly and Forsman 2004). Both first and second generation hybrids were found to be reproductively viable in some cases (Kelly and Forsman 2004).

Geographic Range and Distribution

The current range of the Northern Spotted Owl extends from southwest British Columbia through the Cascade Range, coastal ranges, and intervening forested lands in Washington, Oregon, and northern California, as far south as Marin County (USFWS 1990). The transition between subalpine to alpine forests marks the upper elevation limit at which Northern Spotted Owls are known to occur (Forsman 1975, Forsman et al. 1984). Prior to the mid-1800s, Northern Spotted Owls are believed to have inhabited most old-growth forests or stands throughout the Pacific Northwest, including northwestern California (USFWS 2011a). Although the overall range is not known to have changed, the Spotted Owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon (USFWS 2011a). Local declines have been observed in many portions of the range (see Status and Trends and Barred Owl sections of this report).

The range has been partitioned into 12 physiographic provinces based on landscape subdivisions with different environmental features (Thomas et al. 1990) (Figure 1). This total range of the Northern Spotted Owl has been estimated to have an extent of 230,690 km² (57 million acres) (USDA and USDI 1994).

The 12 physiographic provinces are distributed across the species' range as follows:

- Four provinces in Washington: Eastern Washington Cascades, Olympic Peninsula, Western Washington Cascades, Western Washington Lowlands
- Five provinces in Oregon: Oregon Coast Range, Willamette Valley, Western Oregon Cascades, Eastern Oregon Cascades, Oregon Klamath
- Three provinces in California: California Coast, California Klamath, California Cascades

In California, the Northern Spotted Owl range runs south as far as Marin County in the Coast Ranges and across the Klamath Mountains of northern California east to the Cascade Range where it meets the range of the California Spotted Owl (*S. o. occidentalis*) near the Pit River (Figure 2). The California Coast

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Province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of national forest lands. The California Klamath Province is between the California Coast Province to the west and the California Cascades province to the east, and is a continuation of the Oregon Klamath province, with a southern boundary at the Clear Lake Basin in the inner Coast Range. The California Cascades province is bounded on the west by the Sacramento Valley and the Klamath Mountains, on the east by the Modoc Plateau and Great Basin, and to the south by the Sierra Nevada Mountains (USFWS 1992, Courtney et al. 2008).

Broad-scale patterns of relative abundance of Spotted Owls are suggested by the distribution of recorded Northern Spotted Owl activity centers across the landscape. An activity center is a known Northern Spotted Owl site documented from survey detections (See Appendix 2 for a more detailed definition of activity center). Lower interior densities of Northern Spotted Owl are acknowledged in the 2011 Recovery Plan (USFWS 2011a), which states, "...the dry forest portion of the Spotted Owl's range hosts a minority of the overall population..." Records from the Department's Spotted Owl Database indicate that generally activity centers occur at lower densities in the drier portions of the interior Klamath and Cascade ranges, compared to the Coastal Range and wetter portions of the Klamath Province (Figure 3). It appears many activity centers within the Coast Province have been documented only beginning in the 1990s. This is likely due largely to increased survey effort by private timber companies following the listing by the federal government rather than an increase in Spotted Owl territories in the Coast Province, although Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property in Humboldt and Del Norte counties that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature (GDRC 2015). Humboldt Redwood Company has also reported an increase in number of sites since 2008, but acknowledges the possibility that the increase may be due to the displacement of Spotted Owls to new sites as a result of increasing numbers of Barred Owls (HRC 2015). Large timber companies in the coastal portion of the range have identified a large number of activity centers on their ownerships, with more than 200 activity centers on some ownerships. Consistent with the general pattern, private ownerships in the interior have lower densities of Northern Spotted Owls, but some timber companies still host close to a hundred activity centers (Calforests 2014). Caution must be used when examining these data; activity center sites do not represent the actual number or density of owls across the range in California due to the nature the data are collected and reported. Data are often collected inconsistently based on local project-level monitoring needs and not all data is reported to the database. Also, activity centers are generally retained in the database over time regardless of annual occupancy status (see Status and Trends section of this report).

Reproduction and Development

The Northern Spotted Owl is relatively long-lived with a long reproductive life span (Forsman et al. 1984, Gutiérrez et al. 1995), with wild owls living up to 20 years. Owls are reproductively mature at 1 year of age, but generally do not reproduce for the first time until 2 to 5 years of age. Courtship initiates in February or March, with the first eggs laid in late March through April (Miller et al. 1985, Franklin 1992, Forsman et al. 2002). Timing of breeding onset varies by latitude and elevation, with delayed nesting

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occurring at higher elevations and latitude (Forsman et al. 1993). Females typically lay 1 to 4 eggs per clutch, with 2 eggs per clutch most common (Forsman et al. 1984, USFWS 1990, Anthony et al. 2006). Incubation, performed exclusively by the female, lasts about 30 days (Courtney et al. 2004). Brooding is almost constant for the first 8 to 10 days and is also done exclusively by the female, after which the female will take short trips off of the nest to hunt (Courtney et al. 2004). The male provides all the food to the nest during incubation and the first 10 days of brooding (Courtney et al. 2004). Chicks fledge from the nest in late May or in June and continue to be dependent on their parents into September until they are able to fly and hunt for food on their own (Forsman et al. 1984, USFWS 1990). Adults can typically be found roosting with young during the day for the first few weeks after they leave the nest, after which adults typically only visit their young during the night to deliver food (Forsman et al. 1984). By November, most juveniles begin to disperse (Miller et al. 1997, Forsman et al. 2002, Courtney et al. 2004).

Comment [ABF5]: Should also cite Gutiérrez et al. 1995 and remove the Anthony et al reference (is not really a primary reference for this)

Comment [ABF6]: Should also cite Gutiérrez et al. 1995

Comment [ABF7]: Should also cite Gutiérrez et al. 1995

Most Spotted Owls do not breed every year, but more normally breed every other year (Forsman et al. 2011). The reason for this biennial breeding pattern is unknown, but may be due to the large time investment and energy cost to produce young (Forsman et al. 2011). Annual variation in reproductive success is thought to be related to weather conditions and fluctuations in prey abundance, but may also be related to individual variation, age, and habitat quality within the territory (Forsman et al. 1993, Forsman et al. 2011). Small clutch size, temporal variation in nesting and nest success, and long onset of breeding maturity all contribute to low fecundity for the Northern Spotted Owl (Gutiérrez 1996).

Density

Comment [ABF8]: See my General Comment 1 for the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

Density (i.e., number of individuals per unit of area) estimates for Northern Spotted Owl are difficult to obtain due to the level of effort required to survey all potential habitat in a given area. Density has been estimated for specific study areas, but not across the species' entire range; several estimates of density are available from sites in California (Table 1). Franklin et al. (1990) estimated crude density (territorial owls/km²) of owls in the Willow Creek Study Area, Humboldt County, at 0.235 owls/km² (95% CI = 0.214-0.256), and ecological density (number of individuals/ km² of habitat) at 0.544 owls/km² (95% CI = 0.495-0.592) and 0.660 owls/km² (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km². Diller and Thome (1999) estimated crude density for owls in their northern California coast study area in Humboldt, Trinity and Del Norte counties to be 0.092 owls/km²±0.006, 0.351 owls/km²±0.011, and 0.313 owls/km²±0.017 for Klamath, Korbelt and Mad River regions respectively, with an overall mean density of 0.209 owls/km²±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbelt, and Mad River respectively (Diller and Thome 1999). The 2015 annual report for Green Diamond Resource Company Northern Spotted Owls Habitat Conservation Plan (GDRC 2015) notes a density of 0.17 owls/km² in the northern portion of their land in Humboldt County, and 0.78 owls/km² in southern portions. Sierra Pacific Industry reported 0.450 owls/km² between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km² between 2011 and 2013 on their lands in Trinity, Siskiyou, Shasta, Modoc and Lassen counties (Roberts et al. 2015). In Mendocino County, Mendocino Redwood Company reported a density of 1.89 occupied territories/km² of area surveyed (MRC 2014). Lastly, Humboldt

Comment [ABF9]: GDRC 2015 reported these as owls/1000 acres and not owls/km². These estimates should be reported as 0.042 and 0.192 owls/km², respectively.

Comment [ABF10]: See why these estimates may be incorrect in my General Comment 1 for the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

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Redwood Company (HRC) reported 1.22 occupied territories/km² and 2.23 owls/km² of area surveyed on their lands in Humboldt County (HRC 2013).

Table 1. Density estimates for Northern Spotted Owls within various study areas throughout the range in California.

Source	Density Measure	Location
Franklin et al. 1990	0.235 territorial owls/km ² 0.544 number of owls/ km ² of habitat 0.660 number of owls/ km ² of habitat	Willow Creek Study Area in Humboldt County
Tanner and Gutiérrez1995	0.219 owls/km ²	Redwood National Park in Humboldt County
Diller and Thome 1999	0.092 owls/km ² (Klamath) 0.351 owls/km ² (Korbel) 0.313 owls/km ² (Mad River) 0.209 owls/km ² (mean)	Northern California coast study area in Humboldt, Trinity and Del Norte counties
GDRC 2015	0.170 owls/km ² (northern) 0.780 owls/ km ² (southern)	Green Diamond Resource Company land in Humboldt County
Roberts et al. 2015	0.450 owls/km ² between 1989 and 2003 0.450 owls/km ² between 2003 and 2007 0.459 owls/km ² between 2011 and 2013	Sierra Pacific Industry lands in Trinity, Siskiyou, Shasta, Modoc and Lassen* counties
MRC 2014	1.89 occupied territories/km ² of area surveyed	Mendocino Redwood Company in Mendocino County
HRC 2013	1.22 occupied territories/km ² of area surveyed 2.23 owls/km ² of area surveyed	Humboldt Redwood Company in Humboldt County

Comment [ABF11]: See my General Comment # 1 for changes that need to be made on the values and format of this table

* Densities were reported for Modoc and Lassen counties in this study; however these counties are not within the range of the Northern Spotted Owl. Sierra Pacific Industry lands in this study overlap with the Northern Spotted Owl and California Spotted Owl ranges.

As apparent from the reports of density estimates above, there is considerable variation among studies even though most studies occurred within the coastal forests. This variation in density may be attributed to habitat availability, habitat heterogeneity, territoriality, weather patterns, and presence of Barred Owls (Franklin et al. 1990, Diller and Thome 1999, Courtney et al. 2004 Sovern et al. 2014). Another possible explanation of the variation is that data collection and analysis varied among the studies. Given this, it is nearly impossible to extrapolate density across the entire California range for Northern Spotted Owl.

Hunting and Food Habits

As described in Forsman et al. (1993), Northern Spotted Owls are sit and wait (e.g., perch and pounce) predators. They mostly hunt during nighttime hours (i.e., nocturnal), but will forage during the day as well (Forsman et al. 1984, Sovern et al. 1994, Forsman et al. 2001). Generally, flying squirrels are the main component of the diet in Douglas-fir and western hemlock forest within the northern portion of the owl's range (in Washington and Oregon); whereas in the southern portion of the range (Oregon

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Klamath, California Klamath, and California Coastal Provinces) dusky-footed woodrats are the main component of the diet (Forsman et al. 1984, 2001, 2004, Zabel et al. 1995, Ward et al. 1998, Franklin et al. 2000, Hamer et al. 2001, Dugger et al. 2005). Other prey items seen in the owl's diet in smaller proportions include deer mice, tree voles, red-backed voles, gophers, snowshoe hare, bushy-tailed woodrats, small to medium sized birds, bats, and insects (Forsman et al. 1984, 2001, 2004, Ward et al. 1998, Hamer et al. 2001). A study within the Southern Cascades and Klamath Provinces in California (Timber Products Company timberland) identified 16 species of mammals, 5 species of birds, and 1 species of insect among 224 pellets collected, with major prey items being 58.3% woodrat sp., 29.2% Northern flying squirrel, 3.9 % broadfooted mole, 3.9% rabbit and 1.4% gopher (Farber and Whitaker 2005).

Diet analysis conducted in Washington during the fall and winter months indicated seasonal variation in prey species consumed as a function of the availability of the owls preferred prey species during various portions of the year (Forsman et al. 2001). In the Washington study area, flying squirrels were more prevalent in the diet during fall and winter months, whereas prey species that hibernated or spent the winter under the snow (e.g., chipmunks and pikas) were missing from the diet during the same period. During the spring, summer and early fall months consumption of insects, gophers, and snowshoe hares occurred more frequently (Forsman et al. 2001). Forsman et al. (2001) noted that diets varied among territories even within the same forest type with much of the variation attributed to differences in spatial abundance of prey, but other factors, such as individual preferences, experience, prey accessibility, or timing of pellet collection, may have played a role. While the populations in California are geographically distinct, and hunting and food habits may differ somewhat from owls in Washington, Northern Spotted Owls in California likely vary diet seasonally according to the spatial distribution and abundance of their preferred prey.

Metabolic measurements made on California Spotted Owls in Weathers et al. (2001) showed very low basal metabolic rates compared to other owl species, thereby leading to very low energy requirements. Field metabolic rate on adults actively caring for young averaged only 34% of the metabolic rate predicted for other avian species of the same size (Weathers et al. 2001). Considering this low metabolic rate, Weathers et al. (2001) found that, on average, owls can meet their energy requirements by consuming one northern flying squirrel every 1.8 days or one woodrat every 3.7 days. This low metabolic requirement is likely similar to that of Northern Spotted Owls, though no known study has been conducted on this subspecies.

There is strong evidence that prey abundance and availability affect selection and use of habitat and home range size of Northern Spotted Owls across their range (Zabel et al. 1995). In northwest California, Northern Spotted Owls were found to forage in areas where the occurrence of prey was more predictable, within older forests, and near ecotones of old forest and brush seral stages (Ward 1990 as cited in USFWS 2011a). Owls tend to select old-growth forests with less edge habitat and have larger home ranges when flying squirrels are the dominant prey, whereas they tend to select variable-aged stands with more edge habitat when woodrats are the dominant prey (Courtney et al. 2004). In these variable-aged stands, older forests remain an important component of nesting and roosting habitat.

Comment [ABF12]: Seems that Forsman, E. D., R. G. Anthony, E. C. Meslow, and C. J. Zabel. 2004. Diets and foraging behavior of northern spotted owls in Oregon. *Journal of Raptor Research* 38:214-230 would be more relevant here, especially the southern geographic regions bordering California

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Where woodrats are the dominant prey, the amount of edge between older forests and other habitat types in Oregon was found to have a positive effect on foraging success and subsequent reproductive success due to increased prey availability (Olson et al. 2004). Where woodrats are the primary prey item, young seral stages often provide high quality prey habitat but provide limited foraging opportunities for Spotted Owls due to a lack of perches from which to hunt or to prey inaccessibility in the dense undergrowth; however, when young seral forests are adjacent to older forest stands surplus woodrats may disperse into these older forests making them more vulnerable to predation by Spotted Owls (Meyer et al. 1998, Franklin et al. 2000, Zabel et al. 2003, Olson et al. 2004). In the northwestern California coast redwood zone and the mixed conifer forests in the interior of the California range near Yreka, California, studies have shown that Spotted Owls will forage in recent harvest-created hardwood and shrub habitat (i.e., within 6-30 year old clearcuts) that contain woody debris, scattered conifers and snags, and that are adjacent to older forests (Irwin et al. 2013). Winter use of these areas was more pronounced in areas with 9-18 m²/ha basal area (Irwin et al. 2013).

Home Range and Territoriality

Northern Spotted Owls are territorial. Territories are actively defended using aggressive vocal displays, and even physical confrontations on the rare occasion (Courtney et al. 2004). Because of their high territoriality, broadcast surveys are generally a very effective method for determining presence of Spotted Owls (Courtney et al. 2004); however, calling may be suppressed by the presence of Barred Owls (see Barred Owl section of this report). Territory size for Northern Spotted Owls varies depending on the setting and structure of the habitat (e.g., canopy closure, understory composition, and slope), number of available nesting and roosting sites, and location relative to suitable foraging habitat (Courtney et al. 2004). In general, Spotted Owls have a broad home range with a centrally located nest and roosting site. For this reason, Spotted Owls are considered central place foragers during the breeding season when they are tied to a central nesting or roosting site. Spotted Owls often occupy a home range that is larger than the core use area, and may use an area that is larger than the portion of the home range which is defended (i.e., home ranges may overlap with that of other Spotted Owls). Northern Spotted Owl home ranges generally have a greater amount of older forest near the nest and within the core area use, and more diverse forest types and ages on the periphery of their ranges (Swindle et al. 1999).

Estimates of annual home range size vary across the Northern Spotted Owl's range. The 1990 Conservation Strategy for Northern Spotted Owls (Thomas et al. 1990) reports median annual home range size of owl pairs in various study areas throughout the species' range. Table 2 summarizes home range estimates across the range of the Northern Spotted Owl. Home range estimates from various studies are reported using different analytical tools (e.g., Minimum Convex Polygon, Modified Minimum Convex Polygon, Fixed Kernel, and Adaptive Kernel) and are identified as such in Table 2. Median home range sizes in Oregon and Washington varied from a low of 1411 acres in the mixed conifer forests of the Klamath Mountains (South Umpqua) to a high of 9930 acres in Washington's Olympic Peninsula, consisting mostly of western hemlock with Douglas-fir (Thomas et al. 1990). More recently, Schilling et al. (2013) documented considerably smaller home range sizes in southwestern Oregon's mixed conifer

Comment [ABF13]: See also Franklin et al. 2000 because it applies directly to NSO in California

Comment [ABF14]: Should include Zabel, C. J., K. McKelvey, and J. P. Ward, Jr. 1995. Influence of primary prey on home-range size and habitat-use patterns of northern spotted owls (*Strix occidentalis caurina*). Canadian Journal of Zoology **73**:433-439 here as well since they found similar pattern of owls foraging on edges

Comment [ABF15]: Should use more primary references, such as:
1. Forsman, E. D. 1983. Methods and materials for locating and studying spotted owls. U.S. Forest Service General Technical Report PNW-162, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.
2. Franklin, A. B., D. R. Anderson, E. D. Forsman, K. P. Burnham, and F. W. Wagner. 1996. Methods for collecting and analyzing demographic data on the northern spotted owl. Studies in Avian Biology **17**:12-20.

Comment [ABF16]: See also Bingham and Noon 1997 and Rosenberg, D. K., and K. S. McKelvey. 1999. Estimation of habitat selection for central-place foraging animals. Journal of Wildlife Management **63**:1028-1038, which provides evidence for northern spotted owls as central place foragers

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575 forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference
576 between breeding and nonbreeding seasons. The study showed core area size, annual home range and
577 breeding home range size increased as amount of hard edge increased (Schilling et al. 2013). In their
578 study site in the dry forests of the eastern Cascades in Washington, Forsman et al. (2015) found
579 considerable difference between breeding home range and non-breeding home range, with ranges
580 being 3.5 times larger during the fall and winter months.

581 Home range of Northern Spotted Owls may overlap with those of other neighboring owl pairs,
582 suggesting that the defended area (i.e., territory) is smaller than the area used for foraging (Forsman et
583 al. 1984, Solis and Gutiérrez 1990, Forsman et al. 2015). Northern Spotted Owl home ranges are larger
584 where flying squirrels are the predominant prey, in the northern portion of the range, and smaller
585 where woodrats are the predominant prey, in the southern portion of their range (Zabel et al. 1995,
586 Forsman et al. 2001). Woodrats provide twice the biomass of flying squirrels and therefore are more
587 energetically favorable, which likely explains the smaller home range in the owl's southern portion of
588 the range (Ward et al 1998, Franklin et al. 2000). The portion of the home range used during the
589 breeding season can be significantly smaller than that used in the remainder of the fall and winter
590 (Forsman et al. 1984, Sisco 1990 as cited in USFWS 2011a, Forsman et al. 2015). Forsman et al. (2015)
591 attributes the larger winter home range to prey dynamics and exploratory excursions in search of better
592 habitat.

593

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594 **Table 2.** Summary of annual home range and core home range sizes across the range of the Northern Spotted Owl. MCP = Minimum Convex Polygon, MMCP =
595 Modified Minimum Convex Polygon, FK = Fixed Kernal, and AK = Adaptive Kernal.

Area	Annual Home Range in hectares (+/- one Standard Error)				Core area in hectares	Source
	MCP	MMCP	95% FK	95% AK		
Oregon Coast	1569(463)	1018(160)				Carey et al. 1992
Oregon Coast	1108(137) to 2214(357)		842(115) to 1344(247)		87(6) to 100(5) 95% FK	Glenn et al. 2004
Oregon Coast	2272 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
Oregon Coast	2586 (median)					Thraikill and Meslow pers comm. (as reported in Thomas et al. 1990)
Oregon Coast	1693 (median)					Carey et al. 1990 (as reported in Thomas et al. 1990)
Oregon Klamath	533(58)	472(43)				Carey et al. 1992
Oregon Klamath			576(75)		94(11) 95% FK	Schilling et al. 2013
Oregon Western Cascades	3066(1080)				417(129) AK	Miller et al. 1992
Washington Eastern Cascades	3419(826)		2427(243)			Forsman et al. 2015
Washington Eastern Cascades	3669(876)					King 1993
Washington Western Cascades	2553 (median)					Various references as reported in Thomas et al. 1990
Washington Olympic Peninsula	4019 (median)					Various references as reported in Thomas et al. 1990
California Klamath	1204 to 1341 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
California Klamath	685 (median)					Solis 1983 (as reported in Thomas et al. 1990)
California Coast	786(145)			685(112)	98(22) 95% AK	Pious 1995

Comment [ABF17]: Paton et al. 1990 also reported Adaptive Kernel estimates

Comment [ABF18]: These may be just breeding season home range estimates (not annual). See Sisco, C. L. 1990. Seasonal home range and habitat ecology of spotted owls in northwestern California. Thesis. Humboldt State University, Arcata, Calif for estimates of annual home ranges

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596 *Dispersal*

597 As discussed above, juveniles begin to disperse in the fall, with a few individuals beginning to disperse in
598 early winter. Juvenile dispersal from the parental territory occurs in stages, as juveniles may temporarily
599 settle in locations for up to 7 months before moving on to another temporary location, which may occur
600 several times before individuals establish a territory of their own (Miller et al. 1997, Forsman et al.
601 2002). LaHaye et al. (2001) found that successful juvenile California Spotted Owls often settled in
602 territories previously used by pairs or single owls, which may suggest that owls were able to use some
603 sort of cues that indicated some value of habitat quality when determining a territory of their own
604 (Buchanan 2004).

Comment [ABF19]: See also Gutiérrez, R. J., A. B. Franklin, W. Lahaye, V. J. Meretsky, and J. P. Ward. 1985. Juvenile spotted owl dispersal in northwestern California: preliminary analysis. Pages 60-65 in R. J. Gutierrez and A. B. Carey, editors. Ecology and management of the spotted owl in the Pacific northwest. USDA Forest Service, Portland, Oregon.

605 In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent
606 territory was between 13.5 and 14.6 km (8.4-9.1 mi) for males and between 22.9 and 24.5 km (14.2-15.2
607 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted
608 Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while
609 juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). While the only
610 data available on dispersal pertains to Northern Spotted Owls in Washington and Oregon, and California
611 Spotted Owls in California, we can extrapolate that Northern Spotted Owls in California act similarly,
612 because, while the populations are genetically and geographically distinct, they still share many
613 ecological and behavioral characteristics.

Comment [ABF20]: See Gutiérrez, R. J., A. B. Franklin, W. Lahaye, V. J. Meretsky, and J. P. Ward. 1985. Juvenile spotted owl dispersal in northwestern California: preliminary analysis. Pages 60-65 in R. J. Gutierrez and A. B. Carey, editors. Ecology and management of the spotted owl in the Pacific northwest. USDA Forest Service, Portland, Oregon for data on juvenile dispersal in California.

614 Juvenile Northern Spotted Owls experience high mortality rates (>70% in some areas) during dispersal
615 due to a variety of factors including starvation, predation, and vehicle strikes (Miller 1989, Franklin et al.
616 1999, USFWS 1990, Forsman et al. 2002). Habitat type used during dispersal may also have an effect on
617 mortality. Miller et al. (1997) found that the probability of mortality decreased when dispersing
618 juveniles utilized open sapling forests, but increased when clear cuts were utilized. Successful juvenile
619 dispersal likely depends on locating suitable nesting, roosting and foraging habitat in proximity to other
620 occupied sites or among occupied sites (LaHaye et al. 2001), as well as the presence of suitable habitat
621 to disperse through (Miller et al. 1997, Buchanan 2004).

622 **Habitat Requirements**

Comment [ABF21]: See my General Comment #4 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

623 Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western
624 hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and
625 redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally
626 use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al.
627 1990, Carroll and Johnson 2008, Carroll 2010, USFWS 2011); however, younger forest stands with
628 structural components similar to older forests may also be used by Spotted Owls (USFWS 2011a). The
629 edge between old-growth forest and other vegetation types have also been shown to be important
630 habitat components (Franklin et al. 2000).

631 Throughout the Northern Spotted Owl's range in Washington, Oregon, and California, Bart and Forsman
632 (1992) found owls were about 40 times more common in areas with older forest compared to areas

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633 lacking older forest. In Western Oregon, Meyer et al. (1998) determined that random owl sites
634 contained more old-growth forest than random locations on the neighboring landscape. In
635 Northwestern California, Northern Spotted Owls used old-growth with a higher frequency relative to
636 this forest age class' distribution on the landscape, and similarly, used intermediate to young forests
637 with a lower frequency (Solis and Gutiérrez1990 and Thome et al. 1999).

638 Discussions on habitat components below address range-wide knowledge of Northern Spotted Owl
639 habitat, as well as knowledge of owl habitat specific to California. This report addresses habitat
640 requirements with a focus on major geographic provinces in California. When considering the enormous
641 amount of research on Northern Spotted Owl habitat, careful consideration should be given to
642 California-specific research when evaluating habitat requirements for the species in the state, and in
643 forming conservation and management decisions.

644 *Nesting and Roosting Habitat*

645 Habitat selection has largely been evaluated for nesting and roosting habitat by comparing habitat
646 surrounding occupied Spotted Owl sites to randomly selected sites (Solis and Gutiérrez 1990, Bart and
647 Forsman 1992, Hunter et al. 1995, Thome et al. 1999). Descriptions of nesting and roosting habitat were
648 provided in the early- to mid- 1990s (Solis and Gutiérrez 1990, Thomas et al. 1990, Bart and Forsman
649 1992) and have been validated by extensive research across most of the range of Northern Spotted Owl
650 (Gutiérrez et al. 1995, Hunter et al. 1995, Meyer et al. 1998, Lahaye and Gutiérrez1999, Swindle et al.
651 1999, Weathers et al. 2001, Courtney et al. 2004, USFWS 2008a, USFWS 2011a).

Comment [ABF22]: Also reference Blakesley et al. 1992

652 The following description of nesting and roosting habitat from the Conservation Strategy for the
653 Northern Spotted Owl (Thomas et al. 1990) remains an accurate portrayal of what we know today
654 throughout the range of the owl:

655 "With the exception of recent studies in the coastal redwoods of California, all studies of habitat
656 use suggest that old-growth forests are superior habitat for northern Spotted Owls. Throughout
657 their range and across all seasons, spotted owls consistently concentrated their foraging and
658 roosting in old-growth or mixed-age stands of mature and old-growth trees. Exceptions were
659 found, but even they tended to support the usual observations that spotted owls nested in
660 stands with structures characteristic of older forests....Structural components that distinguish
661 superior spotted owl habitat in Washington, Oregon, and northwestern California include: a
662 multilayered, multispecies canopy dominated by large (>30 inches dbh) conifer overstory trees,
663 and an understory of shade-tolerant conifers or hardwoods; a moderate to high (60-80 percent)
664 canopy closure; substantial decadence in the form of large, live coniferous trees with
665 deformities- such as cavities, broken tops, and dwarf mistletoe infections; numerous large
666 snags; ground cover characterized by large accumulations of logs and other woody debris; and a
667 canopy that is open enough to allow owls to fly within and beneath it."

668 Although this habitat description accurately describes high quality nesting and roosting habitat
669 throughout the range of the Northern Spotted Owl, recent research has shown that Spotted Owls in

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670 California and portions of southwest Oregon use a more diverse set of forest types for foraging. This is
671 described more fully in the Foraging Habitat section of this report.

672 Forested stands with a higher degree of complexity and a high canopy closure are thought to be
673 preferred for nesting and roosting, in part, because they provide protection from predators and thermal
674 exposure (Weathers et al. 2001, Franklin et al. 2000). Hunter et al. (1995) determined nest and roost
675 sites occurred more frequently in mature and old-growth forest in northwestern California (Willow
676 Creek Study Area) relative to availability of these forest types' on the landscape. Both nest and roost
677 sites had similar amounts of mature and old-growth forest types. Whereas sites used for nesting and
678 roosting in the coastal forests of California often contain younger trees than more interior nesting and
679 roosting sites. In the California Coast Province, young redwood forests along the coast have structural
680 complexity similar to that of older forests elsewhere in the Northern Spotted Owl's range. This is due to
681 stump-sprouting and the rapid growth rates of redwoods, together ~~with~~and variable timber
682 management practices (Thomas et al. 1990, Thome et al. 1999, USFWS 2011a, Irwin et al. 2013).

Comment [ABF23]: Incomplete sentence

683 Small-scale spatial habitat requirements in the immediate vicinity of the nest are important but not
684 sufficient to support all activities (e.g., roosting and foraging) conducted at the larger spatial scale
685 (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, USFWS 2011a). Consequently, nesting and
686 roosting habitat is often only a small portion of the entire home range (Forsman et al. 1984, Solis and
687 Gutiérrez 1990, USFWS 2011a).

688 To assess the success of the coordinated forest management plan for federal lands, the Northwest
689 Forest Plan (NWFP; see Northwest Forest Plan section of this report), Davis et al. (2011) developed a
690 habitat suitability map for nesting and roosting habitat across the Northern Spotted Owl range (Figure
691 4). The habitat suitability model was developed using MaxEnt model output, including variables for
692 percent conifer cover, average conifer dbh, amount of large conifer (trees >30 in dbh per acre),
693 diameter diversity, average stand height, and average stand age. Much of the highest suitable habitat is
694 within northwestern California (inclusive of the northern most portion of the California Coast Province
695 and the western portion of the California Klamath Province) and along the coastal forests.

696 *Foraging Habitat*

697 Compared to nesting and roosting habitat, foraging habitat occurs over a much larger portion of the
698 Northern Spotted Owl's home range, often quite distant from the nesting or roosting site. Within a
699 Spotted Owl home range, foraging habitat use may vary seasonally, with a larger area and younger
700 forests used in the non-breeding period (Forsman et al. 1984, Solis and Gutiérrez 1990, USFWS 2011a).
701 Overall foraging habitat consists of areas where the prey species occur and are available (Ward 1990,
702 Zabel et al. 1995).

Comment [ABF24]: See also Ward et al. 1998

703 In California, foraging habitat is generally composed of a more diverse set of forest types and structural
704 characteristics than nesting and roosting habitat. Spotted Owls are difficult to observe during nighttime
705 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and
706 roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry

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studies that document owl locations throughout nighttime movements. Although it is difficult to determine when and where owls are actually obtaining prey, telemetry does provide information on the diversity of forest types used during foraging excursions.

There is a general shift in foraging habitat requirements from north to south within the Northern Spotted Owl range, with foraging habitat in the northern portion of the range being composed of mostly older forests, and in California being composed of a diverse range of forest types from mature to relatively young (USFWS 2009). In the northern portion of the Northern Spotted Owl range where flying squirrels are the dominant prey, foraging habitat may have the same characteristics as nesting and roosting habitat (Gutiérrez 1996, USFWS 2011a). Whereas in the southern portion of their range, where woodrats and voles are the predominant prey species, foraging habitat may include tanoak, oak and younger conifer stands that provide a food source for these prey species (Franklin et al. 2000, USFWS 2009).

Landscape-level analyses in portions of the Klamath Province, where woodrats are the main prey item, suggest that a mosaic of late-successional forests intermixed with various other seral stages may benefit Northern Spotted Owls more than large uniform blocks of older forests (Meyer et al. 1998, Franklin et al. 2000, Zabel et al. 2003). Irwin et al. (2012) found in Oregon and northwestern California that Northern Spotted Owl foraging habitat appeared to be maximized in patches of trees with average quadratic mean diameter¹ of 40 to 55 cm (15-22 inches). Probability of an area being selected for foraging declined rapidly beyond 200 to 300 m (0.12-0.19 miles) from a nest site, yet increased with basal area of hardwoods and with increases in shrub counts (except in areas with high abundance of hardwoods and shrubs).

Within the northern Sierra Nevada Mountains, similar to the mixed conifer Cascade mountain range, Irwin et al. (2007) used radio-telemetry data to assess foraging use parameters of California Spotted Owls. Topography, forest density and heterogeneity, and tree species composition all influenced foraging habitat selection, which in this case was driven by the habitat of the preferred prey, dusky-footed woodrat. Foraging was closely associated with forest stands next to nests and small streams at lower elevations. Intermediate basal area values (35-55 m²/hectares) for Douglas-fir, white fir, and red fir and hardwoods ≥20 cm (≥8 inches) were all positively correlated to foraging habitat use. Owls foraged in sites with an average tree density of 1160 trees/hectare, foraged in stands with 17 large green (>66 centimeter or >26 inch diameter) trees/ha. Use declined with increasing basal area of ponderosa pine. Foraging areas were not strongly associated with roads, slope or aspect.

As noted previously in this report, several studies have shown a benefit of edge habitat for Northern Spotted Owls, as certain habitat types that border older forest may contain higher numbers of preferred prey, the dusky footed woodrat, and surplus prey may venture into older forests that border habitat

¹ Compared to the arithmetic mean, quadratic mean diameter, or QMD, assigns greater weight to larger trees. QMD is always greater than or equal to the arithmetic mean for diameter at breast height for a given set of trees.

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where prey is abundant making them more available to foraging owls (Zabel et al. 1995, Thome et al. 1999, Franklin et al. 2000, Franklin et al. 2013). For instance, Zabel et al. (1995) often found Spotted Owls foraging near transitions between early- and late-seral stage forests stands in northern California, likely where prey species were more abundant or more readily available. Franklin et al. (2000) conducted a modeling effort in northwestern California to help explain variation in both apparent survival and reproductive output. The study found that one of the best models contained a covariate representing the amount of edge between Spotted Owl (defined in the study as mature and old-growth forests with particular characteristics) and other habitats, thereby suggesting that reproductive output and survival are positively influenced by amount of edge, presumably due to increased availability of prey. However, foraging owls have been shown to avoid non-forested areas (e.g., recent clearcuts) and very early forest successional stages (USFWS 2011a, Irwin et al. 2013).

Dispersal Habitat

Generally, it is well accepted that dispersal habitat for Northern Spotted Owls consists of stands with adequate tree size and canopy closure to provide protection from avian predators and that have at least minimal foraging opportunities (Miller et al. 1997, Thomas et al. 1990, Forsman et al. 2002, Buchanan 2004, USFWS 2011a). This may include younger forest stands with less diversity than nesting and roosting habitat, such as even-aged and pole stands, but should at the minimum contain some roosting structures and foraging habitat during this transient stage (Davis et al. 2011, USFWS 2011a). The latest meta-analysis (Forsman et al. 2011) indicates that recruitment of owls into the breeding population likely depends on the amount and quality of dispersal habitat to ensure survival of dispersing owls.

Spotted Owls have been shown to disperse through highly fragmented forest landscapes and seem to use mature and old-growth forests more than that forest type's availability on the landscape during this phase (Miller et al. 1997, Forsman et al. 2002). The USFWS (USFWS 2011) states that corridors of dispersal habitat within fragmented landscapes act to facilitate rapid movement to areas of better habitat. There is little evidence that small openings in forest habitat influence the dispersal of Spotted Owls, but large non-forested valleys may act as barriers to both natal and breeding dispersal (Forsman et al. 2002). Large water bodies may also function as barriers to dispersal, but this is not clearly understood (Forsman et al. 2002).

Thomas et al. (1990) suggests juvenile movement corridors need not be provided on the landscape outside of areas managed as nesting and roosting habitat if 50% of the forest measured on a quarter township basis is forested by trees with average diameter >11 inches and >40 percent canopy closure (i.e., the 50-11-40 rule). Regarding this rule, the USFWS Recovery Plan (2011) states, "the minimum levels of this definition describe habitat supporting the transient phase of dispersal."

A clear understanding of dispersal habitat is key to the management of owl habitat across the Northern Spotted Owl's range. Buchanan (2004) stressed the importance of appropriate management of dispersal habitat and suggests that one of the greatest inadequacies of Spotted Owl habitat management is the lack of retention of structurally complex forest components, such as snags and downed woody debris, at the time of or post timber harvest. Additional studies in California, such as radio telemetry on juvenile

Comment [ABF25]: For California, I would put this in the context of prey density in early seral stages. See:

1. Sakai, H. F., and B. R. Noon. 1993. Dusky-footed woodrat abundance in different-aged forests in northwestern California. *Journal of Wildlife Management* 57:373-382.
2. Sakai, H. F., and B. R. Noon. 1997. Between-habitat movement of dusky-footed woodrats and vulnerability to predation. *Journal of Wildlife Management* 61:343-350.
3. Whitaker, D. A. 2003. Relation of thin and release timber management practices to abundance of woodrats, chipmunks, mice, and ticks within the Hoopa Valley Indian Reservation. MS thesis, Humboldt State University, Arcata, California.

Comment [ABF26]: This seems a loaded statement. I would delete this part of the sentence and replace it with "Current evidence indicates..."

Comment [ABF27]: This is probably mostly conjecture unless there is a study that I don't know about that examined this

Comment [ABF28]: This seems to contradict the first sentence for this subsection (lines 754-757)

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owls, prey abundance and availability, and habitat modeling, are required in order to elucidate specific habitat requirements for and barriers to dispersal.

In an attempt to document the level of change in dispersal habitat, Davis et al. (2011) developed dispersal habitat maps for 1994-2007 using Global Information Systems (GIS), using variables for conifer dbh ≥ 11 inches and conifer cover ≥ 40 percent (Figure 5). The maps also included some amount of nesting and roosting habitat since owls will disperse through these habitat types. Dispersal habitat is continuous in large portions of the northern range in California, with small isolated patches north of Point Arena and in Marin County, in the California Coast Province.

Northern Spotted Owl Habitat Descriptions for Geographic Provinces in California

The forest types within the California range are quite diverse, and consequently, Northern Spotted Owls use the habitat differently among these forest types. Historically the range of the Northern Spotted Owl has been separated into 12 physiographic provinces based on differences in vegetation, soils, geologic history, climate, land ownership and political boundaries (USFWS 2011a; Figure 1); of which three provinces are in California – California Coast, California Klamath, and California Cascade. To better understand the range of forest types used and regional differences that influence habitat quality in California, general owl habitat within each province is described below.

In addition to province segregations, habitat modeling conducted for the 2011 Revised Recovery Plan (USFWS 2011a) identified 11 modeling regions range-wide, five of which occur in California (Figure 6). These modeling regions were developed to capture regional differences in forest environments in acknowledgement of the fact that Northern Spotted Owls exhibit different habitat associations in various portions of their range, and focused on differences in habitat rather than political boundaries or ownership type. For this reason, four of the five modeling regions in California extend into Oregon where similar habitat occurs. Modeling regions that overlap with the California Coast, California Klamath and California Cascade provinces are described below under the appropriate province description.

California Coast Province

A description of the California Coast province is noted below, as defined in the 1992 Northern Spotted Owl recovery plan (USFWS 1992):

“The California Coast province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of national forest lands. The coastal part of the province encompasses the majority of the redwood forest habitat type. Inland forests are Douglas-fir and mixed Douglas-fir/hardwood types, the latter often interspersed with chaparral and grasslands.”

Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) are included in the California Coast Province, the Redwood Coast (RDC) and Interior Coast (ICC) regions. The RDC is described below:

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813 “This region is characterized by low-lying terrain (0 to 900 m) with a maritime climate; generally
814 mesic conditions and moderate temperatures. Climatic conditions are rarely limiting to Spotted
815 Owls at all elevations. Forest communities are dominated by redwood, Douglas-fir-tanoak
816 forest, coast live oak, and tanoak series. The vast majority of the region is in private ownership,
817 dominated by a few large industrial timberland holdings. The results of numerous studies of
818 Spotted Owl habitat relationships suggest stump-sprouting and rapid growth rates of redwoods,
819 combined with high availability of woodrats in patchy, intensively-managed forests, enables
820 Spotted Owls to maintain high densities in a wide range of habitat conditions within the
821 Redwood zone. This modeling region contains the Green Diamond and Marin DSAs [density
822 study areas].” (USFWS 2011a, pg C-9 and C-10).

823 Along the coast of northwestern California young redwood and mixed conifer-hardwood stands appear
824 capable of supporting higher densities of Spotted Owls than younger forests in other regions. This is
825 particularly the case in areas where young hardwood forests provide a multilayered structure (Thomas
826 et al. 1990, Diller and Thome 1999) within a conifer stand. It is important to note here (and is discussed
827 later in the document) that density estimates are not necessarily linked with high quality habitat (i.e.
828 habitat conferring high reproductive success).

829 In young growth coastal forests with a negligible amount of old-growth stands (>200 yr) in Humboldt
830 and Del Norte counties, Thome et al. (1999) found Northern Spotted Owls were positively associated
831 with middle-aged stands (21-40 years-old) that contained larger trees and higher proportions of stands
832 with the largest basal area class (>69 m²/ha), and negatively associated with younger stands that
833 contained smaller trees. Irwin et al. (2013) found that Northern Spotted Owls used patches with more
834 large trees and greater basal area within two study areas in the coastal redwood zone (Fort Bragg and
835 Eureka). It is thought that stump-sprouting and rapid growth rates of redwoods, together with readily
836 available prey (mainly woodrats) and patchy intensively managed stands (e.g., small-patch clearcuts),
837 allows owls to occupy this habitat in higher densities (Thomas et al. 1990, USFWS 2011a). Thome et al.
838 (1999) found that timber management using clearcuts was associated with low reproduction, and
839 therefore recommended clearcuts be restricted to 1.1 km (0.68 mi) beyond the nest site.

840 The ICC differs strikingly from the adjacent coastal redwood region, and is described below:

841 “This region... differs markedly from the adjacent redwood coast region. Marine air moderates
842 winter climate, but precipitation is limited by rain shadow effects from steep elevational
843 gradients (100 to 2,400 m.) along a series of north-south trending mountain ridges. Due to the
844 influence of the adjacent Central Valley, summer temperatures in the interior portions of this
845 region are among the highest within the Spotted Owl’s range. Forest communities tend to be
846 relatively dry mixed conifer, blue and Oregon white oak, and the Douglas-fir-tanoak series.
847 Spotted Owl habitat within this region is poorly known; there are no DSAs and few studies have
848 been conducted here. Spotted Owl habitat data obtained during this project suggests that some
849 Spotted Owls occupy steep canyons dominated by live oak and Douglas-fir; the distribution of
850 dense conifer habitats is limited to higher-elevations on the Mendocino National Forest.”
851 (USFWS 2011a, pg C-12, C-13)

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852 The southern limit of the owl's range in Marin County (part of the California Coast Province and inclusive
853 of both RDC and ICC regions) contains coast redwood, Bishop pine (*Pinus muricata*) and Douglas-fir
854 forests and mixed evergreen-deciduous hardwood forests (e.g., California bay, tanoak and coast live
855 oak) which are regularly used by Spotted Owls (Jenson et al. 2006, USFWS 2011a). Stralberg et al. (2009)
856 found that owls inhabiting Marin County mixed forests were equally likely to be found in conifer
857 dominated stands as they were be to found in hardwood dominated stands, and were negatively
858 affected by habitat fragmentation, yet there did not seem to be a preference for any one tree species
859 when considering owl nest site occurrence. The higher densities of owls and high reproductive success
860 in Marin County may be an indication of a more generalist nature of Marin owls when it comes to
861 habitat selection and the high abundance of woodrats in this area, in contrast to other areas within the
862 Northern Spotted Owl's range in California (Press et al. 2012). The higher use of nest platforms (rather
863 than nest cavities) in the Marin County population is similar to the ratio seen in other younger aged
864 forests, such as in the eastern Cascade Mountains in Washington (Jenson et al. 2006). LaHaye and
865 Gutiérrez (1999) suggested nest type selection depends on the age of the forest, which is supported for
866 the Marin County population where both logging and fire have resulted in younger-aged forests (Jenson
867 et al. 2006).

868 California Klamath Province

869 A description of the California Klamath province is noted below, as defined in the 1992 Northern
870 Spotted Owl recovery plan (USFWS 1992):

871 "The California Klamath province is between the California Coast province and the California
872 Cascades province. It is a continuation of the Oregon Klamath province, south to the Clear Lake
873 Basin in the inner Coast Range. The area is mountainous and covered primarily with Douglas-fir
874 forests. Mixed Douglas-fir/pine forests are common at lower elevations with Douglas-fir/true fir
875 forests at higher elevations."

876 Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) make
877 up the majority of the California Klamath Province, the Western Klamath (KLW) and Eastern Klamath
878 (KLE) regions. The ICC modeling region, which is described above, represents a relatively small southern
879 portion of the California Klamath province. The KLW is described below:

880 "A long north-south trending system of mountains (particularly South Fork Mountain) creates a
881 rain shadow effect that separates this region from more mesic conditions to the west. This
882 region is characterized by very high climatic and vegetative diversity resulting from steep
883 gradients of elevation, dissected topography, and the influence of marine air (relatively high
884 potential precipitation). These conditions support a highly diverse mix of mesic forest
885 communities such as Pacific Douglas-fir, Douglas-fir tanoak, and mixed evergreen forest
886 interspersed with more xeric forest types. Overall, the distribution of tanoak is a dominant
887 factor distinguishing the Western Klamath Region. Douglas-fir dwarf mistletoe is uncommon and
888 seldom used for nesting platforms by Spotted Owls. The prey base of Spotted Owls within the
889 Western Klamath is diverse, but dominated by woodrats and flying squirrels. This region

Comment [ABF29]: I really did not see evidence for this in Press et al. (2012); the estimates they reported seemed similar to other parts of the owl's range in California.

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890 contains the Willow Creek, Hoopa, and the western half of the Oregon Klamath DSAs.” (USFWS
891 2011a, pg C-12)

892 The KLE differs from KLW by the reduced influence of marine air and a slightly varying forest
893 composition. The KLE is described below:

894 “This region is characterized by a Mediterranean climate, greatly reduced influence of marine
895 air, and steep, dissected terrain. Franklin and Dyrness ([1973]) differentiate the mixed conifer
896 forest occurring on the “Cascade side of the Klamath from the more mesic mixed evergreen
897 forests on the western portion (Siskiyou Mountains), and Kuchler (1977) separates out the
898 eastern Klamath based on increased occurrence of ponderosa pine. The mixed
899 conifer/evergreen hardwood forest types typical of the Klamath region extend into the southern
900 Cascades in the vicinity of Roseburg and the North Umpqua River, where they grade into the
901 western hemlock forest typical of the Cascades. High summer temperatures and a mosaic of
902 open forest conditions and Oregon white oak woodlands act to influence Spotted Owl
903 distribution in this region. Spotted Owls occur at elevations up to 1768 m. Dwarf mistletoe
904 provides an important component of nesting habitat, enabling Spotted Owls to nest within
905 stands of relatively younger, small trees. The western half of the South Cascades DSA and the
906 eastern half of the Klamath DSA are located within this modeling region.” (USFWS 2011a, pg C-
907 12)

908 As mentioned above, Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) provides an important
909 component of nesting habitat, enabling Northern Spotted Owls to nest within stands of relatively
910 younger small trees (USFWS 2011a). Its distribution coincides with the distribution of Douglas-fir from
911 southern British Columbia to central Mexico (Hadfield et al. 2000).

912 The propensity for Northern Spotted Owls to utilize old structurally complex forests in the California
913 Klamath Province for nesting and roosting is supported by numerous studies on public and private
914 timberlands. Table 3 provides a detailed summary of habitat studies in the Klamath Province. Foraging
915 habitat may contain the typical older forest components of nesting and roosting habitat, but may also
916 include younger forests, hardwood stands, and more open areas (Solis and Gutiérrez 1990, Zabel et al.
917 1995, Irwin et al. 2012, Irwin et al. 2013).

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Table 3. Description of suitable habitat from studies of Northern Spotted Owl habitat relationships in the Klamath Province (partially adapted from USFWS 2009, Table III.C.1).

Study	Location	Method	Description of Selected or Suitable Habitat
USFWS 1992, Bart 1995	Washington, Oregon, northern California	research synthesis (various methods)	conifer-dominated forest with a multi-layered canopy, average DBH1 >30 inches, >60% canopy cover, decadence (snags, logs, deformed trees)
Anthony and Wagner 1999	southwestern Oregon	aerial photographs, ground reconnaissance	conifer-dominated forest with a multi layered canopy, >40% canopy cover, decadence, large snags and logs; characterized by trees >30 inches DBH and >200 yrs
Blakesley et al. 1992	northwestern California	ground sampling, USFS timber stratum maps	coniferous forest characterized by trees >53.3 cm in diameter, forests at 300-900 m elevations for roosting, and the lower third of slopes within a specific drainage
Carey et al. 1992	southwestern Oregon	aerial photographs, forest inventory data, ground reconnaissance	multi-layered canopy, average DBH of dominant trees >39.4 inches, large snags and logs
Dugger et al. 2005	southwestern Oregon	aerial photographs, ground reconnaissance	conifer or mixed forest, >100 yrs; characterized by trees >13.8 inches DBH
Franklin et al. 2000	northwestern California	satellite imagery	forest comprised of >40% conifers, conifer QMD2 >21 inches, hardwood QMD >6 inches, canopy cover >70%
Gutiérrez et al. 1998	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Hunter et al. 1995	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Irwin et al. 2012	southwestern Oregon and northcentral California	ground sampling, modeling	Selection tied to increasing average diameter of coniferous trees and also with increasing basal area of Douglas-fir trees, increased with increasing basal areas of sugar pine hardwood trees and with increasing density of understory shrubs. Large-diameter trees (>66 cm) appeared important <400 m from nest sites.
Irwin et al. 2013	southwestern Oregon and northcentral California	forest inventory from private and federal landowners, modeling	Basal area (m ² /ha) between 35-60 in nesting period, and 30-54 in winter period, basal area of trees >66 cm was between 7-22 in nesting period, and 7-18 in winter period, QMD 37-60 in nesting period and 37-61 in winter period.
LaHaye and Gutiérrez1999	northwestern California	ground sampling	83% of nests located in Douglas-fir, 60% of nests located in brokentop trees, nest within forests characterized by large (> 90 cm dbh) conifers, a hardwood understory, and a variety of tree

Comment [ABF30]: See Franklin, A. B., and R. J. Gutiérrez. 2002. Spotted owls, forest fragmentation, and forest heterogeneity. *Studies in Avian Biology* 25:203-220 for why some of these descriptions may not entirely capture spotted owl habitat in some parts of its range (e.g., CA Klamath)

Comment [ABF31]: These were also extensively groundtruthed through ground reconnaissance

Comment [ABF32]: But this only partially describes NSO habitat in that study

Comment [ABF33]: These were also extensively groundtruthed through ground reconnaissance

Comment [ABF34]: These were also extensively groundtruthed through ground reconnaissance

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			sizes.
Meyer et al. 1998	western Oregon	aerial photographs	conifer-dominated forest, trees >80 yrs and/or multi-layered canopy
Ripple et al. 1997	southwestern Oregon	aerial photographs	conifer-dominated forest, average DBH >19.7 inches, canopy cover >60%
Solis and Gutiérrez 1990	northwestern California	timber type classification	average DBH >20.7 inches
Zabel et al. 1993	northwestern California	topographic maps, aerial photographs, and orthophotoquads	stands dominated (in terms of basal area) by trees >20.9 inches DBH; >20% canopy cover of dominant trees and >70% canopy cover of trees >5.1 inches DBH
Zabel et al. 2003	northwestern California	modified timber type classification, varied geographically	<u>nesting-roosting habitat</u> : for most locations average DBH >17 inches and average conifer canopy cover >60%; <u>foraging habitat</u> : in all locations average DBH >9.8 inches and average conifer canopy cover >40%, additional criteria in some locations

Comment [ABF35]: Need to include hardwood component here and elsewhere (see my General Comment 3 under the THREATS section)

921

922 California Cascade Province

923 A description of the California Cascades province is noted below, as defined in the 1992 Northern
924 Spotted Owl recovery plan (USFWS 1992):

925 “The California Cascades province is bordered by the Oregon Cascades province, the Oregon and
926 California Klamath provinces, and the north end of the Sierra Nevada. It is the link between the
927 range of the northern Spotted Owl and the range of the California Spotted Owl. Suitable owl
928 habitat, which is fragmented on a broad scale by high- and low-elevation areas containing
929 marginal habitat, is predominately in two national forests. However, there are significant blocks
930 and checkerboard ownership areas where industrial private lands can provide suitable habitat.”

931 One modeling region described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) makes
932 up the majority of the California Cascades province, Eastern Cascade - South (ECS). The ICC modeling
933 region, which is described above, represents a relatively small southern portion of the California
934 Cascades province. The ECS is described below:

935 “Topography is gentler and less dissected than the glaciated northern section of the eastern
936 Cascades. A large expanse of recent volcanic soils (pumice region: Franklin and Dyrness [1973]),
937 large areas of lodgepole pine, and increasing presence of red fir and white fir (and decreasing
938 grand fir) along a south-trending gradient further supported separation of this region from the
939 northern portion of the eastern Cascades. This region is characterized by a continental climate
940 (cold, snowy winters and dry summers) and a high-frequency/low-mixed severity fire regime.
941 Ponderosa pine is a dominant forest type at mid-to lower elevations, with a narrow band of

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942 Douglas fir and white fir at middle elevations providing the majority of Spotted Owl habitat.
943 Dwarf mistletoe provides an important component of nesting habitat, enabling Spotted Owls to
944 nest within stands of relatively younger, smaller trees.” (USFWS 2011a, pg C-11, C-12)

945 Compared to other provinces in California, very little is known about the specific needs of the Northern
946 Spotted Owl in the California Cascades. In addition, no studies have been conducted to date evaluating
947 habitat quality (the amount and type of habitat most beneficial to owls) across owl sites in the California
948 Cascade Province. Recent telemetry work on foraging habitat use and selection has been conducted on
949 three large study areas at the interface of the southern Cascades and eastern Klamath Mountains in
950 southern Oregon and north-central California (Irwin et al. 2012, 2013). These studies provide valuable
951 information on foraging habitat use in the California Cascade region, but without demographic
952 performance information the results have limited utility for identifying the habitat’s quality for owls.

Comment [ABF36]: However, Dugger et al 2005 provides some information just across the border in Oregon

953 Irwin et al. (2012 and 2013) found that Northern Spotted Owls in Oregon and northwestern California
954 selected areas with greater density and basal area of trees >66 cm dbh (>26 dbh) within 400 m (0.25 mi)
955 of nest sites. The authors suggest a plausible optimal landscape for Spotted Owls in the region might
956 include stands of large-diameter trees near nest sites which are embedded in a heterogeneous forest
957 landscape of various selected foraging types. Modeling owl habitat based upon characteristics used
958 during nighttime foraging excursions, Irwin et al. (2012) found that owls selected mixed-aged and mixed
959 coniferous forest stands. In this study, the Yreka study site was inclusive of dry forest types on the
960 California Cascade Province.

Comment [ABF37]: See my General Comment 2 under BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section concerning use of the term “modeling ”

961 In a modeling effort within the Klamath and Cascade provinces, habitat parameters were compared
962 among all forest types within the owls range in California, Oregon and Washington (considered habitat
963 across the entire range at the time) with that of California-specific knowledge of owl habitat within
964 Klamath and Cascade provinces (Zabel et al. 2003). These revised parameters considered new nesting,
965 roosting and foraging habitat types and attributes (e.g., younger trees, elevation, aspect, California-
966 specific soil classes) that the range-wide habitat map left out. The revised model performed better at
967 predicting owl occupancy in California’s interior forest types than the range-wide model. The study
968 concluded that modeling California habitat independent of range-wide habitat was more effective at
969 predicting owl occupancy and numbers in California interior forest types.

970 *Habitat Effects on Survival and Reproduction*

971 Habitat quality has been evaluated in a number of ways including: assessing density of owls in different
972 habitat types, comparing vital rates between owl sites with different habitat conditions,
973 ~~estimating modeling~~ vital rates for populations of owls across broad areas that exhibit differences in
974 landscape scale forest composition, and ~~estimating modeling~~ vital rates at individual owl territories with
975 specific forest structure and composition. The type, extent, and spatial configuration of forests in a high
976 quality territory vary across the range of the Northern Spotted Owl and across regions of California.
977 Although many different combinations of habitat can support a productive Northern Spotted Owl pair
978 with high fitness, the body of evidence suggests minimum thresholds for amounts and distributions of
979 various forest types within any given Northern Spotted Owl home range.

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980 In the recent broad demographic analysis (Forsman et al. 2011), habitat variables were evaluated for
981 effect on fecundity, survival, and rate of population change. Habitat data were not available for
982 California, and so effect of habitat on demographic rates could only be evaluated for Oregon and
983 Washington. In all Oregon study areas, modeling revealed strong evidence for an effect of suitable
984 habitat on fecundity. Four of five Oregon study areas showed declines in fecundity with decreases in
985 suitable habitat, however, the Klamath study area of southwest Oregon showed the opposite
986 relationship, with fecundity declining with increases in suitable habitat. The latter result is consistent
987 with one territory-based analyses in the Klamath province in California which showed an increase in
988 fecundity with decreases in mature forest (Franklin et al. 2000), but is inconsistent with a territory-based
989 analysis in the Klamath province of southern Oregon (Dugger et al. 2005). An additional study in
990 southern Oregon, although not in the Klamath Province, also showed an increase in fecundity with
991 decreases in mature forest (Olson et al. 2004).

Comment [ABF38]: The Dugger et al. 2005 study area was more in the Cascade provinces than the Klamath province (see my General Comment 4 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section)

992 There was weak evidence for a relationship between the percent cover of suitable habitat and apparent
993 survival for four study areas in Oregon and Washington (Forsman et al. 2011). This is in contrast to three
994 territory-based analyses in California and southern Oregon which found positive relationships between
995 survival and mature forest (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). It is likely that
996 habitat influences demographic rates of individual spotted owls on a home range or territory scale.
997 Therefore where finer-scale data have been available, studies conducted at the scale of owl territories
998 are more likely to detect an effect and are likely more representative of individual Spotted Owl habitat
999 requirements than the broad meta-analysis.

1000 Territory-based studies have revealed that owls occupy sites that vary in quality, with pairs exhibiting
1001 various levels of survival and productivity in association with habitat type. For example, Bart and
1002 Forsman (1992) found that Northern Spotted Owl productivity increased with increasing amount of
1003 older forests. Similarly, using turnover rates to define survival Bart and Ernst (1992) found that adults
1004 remained in a territory longer when mature and old-growth was present within the territory.

Comment [ABF39]: Need to be careful here because Bart & Forsman also used 20-690 km² compartments containing multiple territories, which were not territory-based but based on groups of territories.

1005 Certain habitat characteristics have been shown to support high quality Northern Spotted Owl
1006 territories, with both the amount and spatial configuration of different habitat types at a territory
1007 contributing to levels of survival and productivity in the resident owls. This measure of habitat quality at
1008 the scale of Northern Spotted Owl home range has been termed "habitat fitness potential" (HFP). HFP
1009 was defined by Franklin et al. (2000) as "...the fitness conferred on an individual occupying a territory of
1010 certain habitat characteristics." and is determined by modeled values of lambda (λ ; defined as annual
1011 rate of population change²) and the rates of survival and reproduction that influence λ (Franklin et al.
1012 2000, Olson et al. 2004, Dugger et al. 2005). The habitat characteristics that influence HFP include the
1013 amount of nesting, roosting, and foraging habitat, as well as the amount of non-habitat. The spatial
1014 configuration of these different habitat types around an activity center has also been shown to be

² See section on Demographic Rates below for a discussion of lambda and fitness.

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important in determining HFP. Studies that have evaluated HFP vary somewhat in the size of core areas evaluated and some have evaluated a broader area representing the broader home range. Studies have occurred in southwestern Oregon and northwestern California and so represent different geographic areas and forest types, although most are largely in the Klamath Province of Oregon and California. Three territory-based studies at study areas in the interior of California and southern Oregon have found fairly strong associations between habitat characteristics and demographic rates of northern spotted owls (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). These studies are summarized below and in Table 4.

Each of the three studies attempted to evaluate the effect that older forests (representing nesting/roosting habitat) and other habitat components have on owl demographic rates. In all cases the authors have attempted to capture habitat composed of the oldest forests in the study area to represent high quality nesting and roosting habitat, based on the strong association of the Northern Spotted Owl with mature and old-growth forests. Availability of data for each study area resulted in different definitions of nesting and roosting habitat in each study. Depending on the study, additional attributes evaluated included nonhabitat (e.g., nonforested areas) and amount of edge between various land cover types.

Franklin et al. (2000) modeled the relationship between owl habitat covariates in the core area of Spotted Owl home ranges and Northern Spotted Owl fitness in portions of the north Coast Range and the Klamath Mountains in California. In this study, Northern Spotted Owl habitat was defined as “mature and old-growth forest with a quadratic mean diameter of ≥ 53 cm, quadratic mean diameter of hardwoods ≥ 15 cm, percentage of conifers $\geq 40\%$, and overstory canopy coverage of $\geq 70\%$.” Apparent survival increased with an increased amount of owl habitat, with the amount of edge between owl habitat and other habitat, and at intermediate distances between patches and owl habitat. There was a rapid decrease in survival when the amount of owl habitat fell below about 100 acres (40 hectares) of owl habitat within the core use area. Reproductive rate also increased with an increase of edge between owl habitat and other habitat types, but decreased with increasing amount of owl habitat. Reproductive output had a non-linear relationship with amount of owl habitat, only increasing substantially when the amount of owl habitat was less than 75 to 100 acres (30 to 40 hectares). Variation in survival was attributed mostly to habitat, whereas variation in reproductive output was attributed to both to habitat and climatic events (e.g., cold heavy rains during peak breeding season). HFP was maximized in sites with sufficient owl habitat to facilitate high survival and sufficient edge to facilitate both high survival and high reproductive output. Given this, the authors suggest that there is a trade-off between the amount of owl habitat and edge required to maximize survival and reproduction, while at the same time noting that the components of quality edge habitat are still poorly understood since the study did not discriminate between types or amount of “other habitat”. Despite the trade-off between survival and reproduction, estimates of λ have been shown to be driven by survival rates in Northern Spotted Owls (Forsman et al. 2011), and “...low amounts of spotted owl habitat within a territory will not supply the high degree of edge predicted to support high reproductive output” (Franklin et al. 2000).

Comment [ABF40]: But also whether core areas were static (e.g., placed on geometric means of annual activity centers) or dynamic (e.g., shifted each year based on annual activity centers). There were pros and cons to each approach but some of the subtle differences may have been due to this.

Comment [ABF41]: This is not completely accurate because these studies also included alternate hypotheses concerning edge and interior forest to examine whether northern spotted owls were primarily an interior, edge, or mixed interior-edge species.

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1054 **Table 4.** Comparison of three territory-based demographic studies in the interior of California and southern
1055 Oregon.

	Franklin et al. 2000	Olson et al. 2004	Dugger et al. 2005
Definition of older forest evaluated in the study (representing nesting/roosting habitat)	Spotted owl habitat = mature and old-growth forest with QMD of conifers >53 cm (~21 in), QMD of hardwoods >15 cm (~6 in), percentage of conifers >40%, and overstory canopy coverage >70%	<u>Late-seral forest</u> = stands characterized by trees with >80 cm (~31.5 in) dbh; generally associated with high quality nesting, roosting, and foraging habitat. <u>Mid-seral forest</u> = stands characterized by trees with 24-80 cm (9.5 - 31.5 in) dbh.	<u>Old forest</u> = older (>100 years) conifer or mixed stands characterized by canopy cover >40% and trees >35cm (~14 in) dbh. <u>Old growth</u> = old (>200 years) conifer-dominated stands characterized by canopy cover >40% and trees >75 cm (~29.5 in) dbh.
Relationship between older forest and <u>survival</u>	Positive Survival declined rapidly at sites with less than ~100 acres of spotted owl habitat in the core area (i.e. <25%) Core area = 390 acres	Positive In general, late-seral forest had a positive effect on survival. However, the best model showed highest survival when combined mid- and late-seral forest was about 70% of the 1,747 acre (1,500-m radius) circle	Positive Pseudothreshold relationship with survival rate dropping rapidly when proportion of old forest in the core drops below ~20-30% (~80-100 acres) Core area = ~413 acres
Relationship between older forest and <u>productivity</u>	Negative Nonlinear relationship with reproductive output increasing when amount of older forest in the core area is less than ~75-100 acres	Negative Productivity declined with increases in mid- and late-seral forest	Positive Linear effect with old growth forest in the core area providing the best model
Amount of older forest in the core area for high fitness territories^a	Variable, with an apparent trade-off between providing sufficient older forest to support survival and provide a high amount of edge, while limiting portion of core area in older forest in order to support high productivity (see Fig 10 in Franklin et al.; generally at least ~25% older forest required in core to support high fitness)	N/A The best model included only the 1,500m diameter circle (~1,747 acres representing broader home range)	In general, territories with <40% of the 413 acre core (~165 acres) composed of older forests had habitat fitness potential <1.0
Effect of habitat in broader home range or 'outer ring' on vital rates^b	N/A	Territories with high estimates for λ had a high amount of mid- and late-seral forest in the 1,747 acre area, but also have patches of nonforest within the mosaic of forest types	Survival declined when the amount of nonhabitat in the outer ring portion of the home range exceeded about 60%.
Relationship of vital rates with the amount of non-habitat (non-forest areas, sapling stands, etc.)	Did not evaluate ^c	Increases in early seral and nonforest had a negative effect on survival	Survival decreased dramatically when the amount of non-habitat exceeded ~50% of the home range

Comment [ABF42]: See my General Comment 4 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

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Relationship of vital rates with amount of edge between older forest and other vegetation types ^d	Both apparent survival and reproductive output increased with increasing edge between spotted owl habitat and other vegetation types ^e	The best model showed a positive relationship between productivity and amount of edge between mid- and late-seral forest and the other types (early-seral and nonforest).	No support for either a positive or negative effect on survival or reproductive rate
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^aSize of the core area evaluated varies across studies. Franklin et al. (2000) evaluated a 390 acre core area. Olson et al. (2004) evaluated a ~279 acre core area, but their best model included only the 1,500m diameter circle (~1,747 acres). Dugger et al. (2005) evaluated a ~413 acre core area.

^bSize of the broader home range or 'outer ring' evaluated varies across studies. Franklin et al. (2000) did not include an outer ring of habitat or broader home range in their modeling. Dugger et al. (2005) evaluated a ~3,455 acre outer ring. In addition to the core area, Olson et al. (2004) evaluated two larger circles of habitat of ~1,747 and ~4,473 acres.

^cFranklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types.

^dEdge is defined differently among the studies. Franklin et al. (2000) defined edge as occurring between mature forest (spotted owl habitat) and all other vegetation types. Olson et al. (2004) and Dugger et al. (2005) define edge as occurring between nonhabitat and all intermediate and mature forest types.

^eFranklin et al. (2000) were unable to distinguish different types of edge, but suggested that edges between spotted owl habitat and clearcuts do not generate the type of mosaic that was observed in high-fitness territories.

In their Oregon coast study area, Olson et al. (2004) analyzed various forest types: late-seral, mid-seral (broken further into conifer and broadleaf), and non-forest, within 600, 1,500 and 2,400 m radius around Northern Spotted Owl site centers. The best statistical model indicated survival was highest when the amount of mid- and late-seral forest was about 70% within the 1,500 m (0.9 mi) radius circle, and survival decreased when the amount of mid- and late-seral forest increased above about 85% or declined below about 50%. Increases in early seral or non-forest had a negative effect on survival. The best model indicated reproductive rates were positively correlated to the amount of edge between mid-seral and late-seral forest and other forest types (early-seral or non-forest), and suggested a high amount of mid- and late-seral forest in the 1,747 acre area with patches of nonforest within the mosaic of forest types provided high fitness.

In an Oregon study (including portions of the western Cascades and eastern Siskiyou Mountains, both comparable to areas in California), Dugger et al. (2005) found the best models contained a positive linear effect of older forest types in the core area (defined as 413 acres) on reproductive rate, with the best model including old-growth. There was strong evidence to support a positive relationship between amount of older forest types in the core area, and an increase in apparent survival. Dugger et al. (2005) found little to no effect on survival and reproduction rate for intermediate-aged forests, defined as forests between sapling and mature stages with total canopy cover over 40%. The study also analyzed habitat within a broader area around the core area, representing an outer ring of the home range (3,455 acres outside of the core area). Within the broader area, survival declined when the amount of non-habitat, defined as non-forest and early seral stages including sapling stage, within the ring outside the core area exceeded 60%. Survival estimates were highest when the amount of non-habitat fell between roughly 20 to 60% in the broader portion of the home range, and survival estimates were lower as non-habitat fell below 20% or above 60%. Modeling efforts did not find any direct effect of edge, although edge was defined differently than in the Franklin et al. (2000) study. Although Dugger et al. (2005) did

Comment [ABF43]: But was also in a different province with different dominant prey species (see my General Comment 4 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

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1093 not find any evidence that a mosaic of old forest intermixed with forests of intermediate age (with
1094 hardwood component) provided benefit to the Northern Spotted Owl, nor a benefit of edge, the
1095 negative quadratic relationship between owl survival and amount of non-habitat in the broader portion
1096 of the home range may suggest some benefit of an intermediate amount of “edge” in this larger area.
1097 The study concludes, “in general, territories with <40% old forest or old-growth habitat near the site
1098 center had habitat fitness potential <1, consistent with the relationships between both reproduction
1099 and survival and the amount of old forest habitat at the core.”

1100 All three of the above studies found a positive relationship between the amount of late-seral forest and
1101 survival, with two (Franklin et al. 2000, Dugger et al. 2005) showing a rapid decline in survival when the
1102 amount of late-seral forest in the core area dropped below about 25% (i.e., about 100 acres of late-seral
1103 forest is required in the 400 acre core to support survival). The third study (Olson et al. 2004) found that
1104 declines in survival accelerated when the amount of mid- and late-seral forest in a larger area (~1,750
1105 acre) declined below 50%, with highest survival at 70% mid- and late-seral forest. Two of the three
1106 studies found a negative relationship between the amount of older forest and productivity in the core
1107 area (Franklin et al. 2000) or in the broader home range (Olson et al. 2004); this shows an apparent
1108 trade-off between providing sufficient older forest to support survival, while limiting the amount of
1109 older forest in order to support high productivity. The third study found a positive relationship between
1110 older forest in the core area and productivity (Dugger et al. 2005).

1111 Dugger et al. (2005) found that territories required that about 40% of the core area be composed of
1112 older forests in order for HFP to be greater than 1.0. The results of Franklin et al. (2000) suggest that
1113 about 25% of the core area must be in older forest to support high fitness. The two studies that
1114 evaluated a broader home range found that the amount of non-forested area and other forms of
1115 nonhabitat must be limited in order to support high HFP (Olson et al. 2004, Dugger et al. 2005). Olson et
1116 al. (2004) and Dugger et al. (2005) both found that survival decreased dramatically when the amount of
1117 early seral forest or other non-habitat exceeded ~50% of the home range.

1118 In their coastal study area within California’s Humboldt and Del Norte counties, Thome et al. (1999)
1119 showed that reproductive rate was inversely related to age class and basal area age classes within
1120 forests managed with clear-cut silviculture practices. Specifically, sites with high proportions of 21-40
1121 year-old stands, lower proportions of 61-80 year-old stands and the largest basal area class (>69 m²/ha)
1122 had higher reproduction; however sites with higher reproduction also had more residual trees at 50
1123 hectare circle (0.149 trees/ha) and 114 hectare circle (0.201 trees/ha) surrounding owl sites. The
1124 explanation was presumed to be related to the larger abundance of preferred prey (i.e., woodrats)
1125 among younger forests coupled with the limited availability of older forests on the study area. The
1126 authors concluded that 21-40 year-old stands were young enough to contain sufficient amounts of prey
1127 during foraging, yet old enough to provide structural for roosting, nesting, and maneuverability, such as
1128 high canopy and large residual trees.

1129 It is important to note that the relationships found between owl fitness and habitat in the studies
1130 described above apply only to areas with similar conditions as those analyzed as part of the studies, and
1131 findings may not be applicable to owl territories throughout the owl’s entire range in California. For

Comment [ABF44]: Need to use consistent terminology throughout this subsection. Productivity in Olson et al. 2005 was synonymous with reproductive output in Franklin et al 2000.

Comment [ABF45]: Also see:
1. Sakai, H. F., and B. R. Noon. 1993. Dusky-footed woodrat abundance in different-aged forests in northwestern California. *Journal of Wildlife Management* 57:373-382.
2. Sakai, H. F., and B. R. Noon. 1997. Between-habitat movement of dusky-footed woodrats and vulnerability to predation. *Journal of Wildlife Management* 61:343-350.
3. Whitaker, D. A. 2003. Relation of thin and release timber management practices to abundance of woodrats, chipmunks, mice, and ticks within the Hoopa Valley Indian Reservation. MS thesis, Humboldt State University, Arcata, California.

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example, the study area described in Olson et al. (2005) comprised different forest types than those described in Dugger et al. (2005) or Franklin et al. (2000) and where the primary food source was flying squirrels rather than woodrats.

Overall, Northern Spotted Owls require some minimum level of old forest, including old-growth, within their core range and broader range to optimize survival and productivity. It is also apparent that older forest mixed with other forest types (excluding non-habitat) benefits Northern Spotted Owl fitness, at least partially due to the increased foraging opportunities along transitional edges. This effect may be more prevalent in the interior zones of California and southern Oregon, (Klamath and Cascade provinces) where owl habitat differs significantly than coastal or more northern portions of the range. In spite of uncertainties around which level of old forest and edge attains the best fitness for owls, the literature points to the benefits of a mosaic of forest types that contain sufficient older forest, especially around the core area, while limiting the amount of nonhabitat in the home range. Based on the studies in the interior of the species' range in California and southern Oregon, management that maximizes late-seral forest in the core area (at least 25-40%) while limiting the amount of nonforest or sapling cover types throughout the home range (no more than about 50%) would likely result in high quality Spotted Owl territories.

Comment [ABF46]: This is a key point that may drive differences in spotted owl habitat in California. I would emphasize this early on. Also see my General Comment 4 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section.

Comment [ABF47]: The use of edges probably also depend on whether the primary prey are associate with early seral stages or interior forest

Comment [A48]: Note to external reviewers: Prior to final draft, we will consider adding Figure 6 from Dugger et al. (2005) or Figure 10 from Franklin et al. (2000) to illustrate the amounts and configuration of various habitat types in high quality territories.

Status and Trends in California

Abundance

No range-wide estimate for abundance of Northern Spotted Owl exists because survey methods and effort conducted to date do not provide for reliable estimation of population size across the range (USFWS 2011a). Few areas across the range have been sufficiently sampled to accurately estimate densities of Northern Spotted Owls (Franklin et al. 1990, Tanner and Gutiérrez 1995, Diller and Thome 1999). As mentioned above, Northern Spotted Owl densities vary across the range and forest types and so extrapolating the few local estimates across the range of the subspecies would result in biased estimates of abundance (See Life History section of this report for detailed information in density estimates in California). Because Northern Spotted Owls have large home ranges it is necessary to systematically survey very large areas in order to obtain reliable estimates of density (Franklin et al. 1990). Diller and Thome (1999) suggested that unless most individuals in a population are marked, density estimates would be biased. Studies that have provided density estimates have applied only to territorial owls (Diller and Thome 1999). Surveys do not effectively sample nonterritorial individuals (floaters); therefore, little is known about the floater population of owls other than they exist and that they generally do not respond to broadcast surveys. This leads to an issue of detectability that is difficult to overcome in estimating density or abundance of Northern Spotted Owls in a given area. Without an effective sampling method that addresses the ability to detect all owls in a given area, it is not possible to provide an accurate estimate of abundance. See the discussion on occupancy in the Demographic Rates section of this report for potential effects of floater owls on occupancy rates at known owl sites.

Comment [ABF49]: This also depends on what inferences are. The issue of floaters is less problematic if inferences are to territorial owls (as opposed to territorial owls + floaters)

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An early report out of the California Forestry Association (Taylor 1993) attempted to derive a population estimate for the Klamath Province in California. However, many assumptions were required in the analysis process, especially in developing estimates for amount of suitable habitat on federal and private land, estimating the fraction of land that had previously been surveyed, and estimating the proportion of sites that are occupied. In addition, no criteria were mentioned for what constituted “suitable” habitat, although 100% of forested land not owned by the USFS was considered to be suitable. The paper acknowledges that several of the assumptions made in deriving the population estimate are untested and that high levels of uncertainty exist in many of the estimates. Taylor (1993) partitioned land into ownership type, estimated the amount of suitable habitat on each type, estimated the fraction of land surveyed on each type, used the number of activity centers in the Department database and the estimates for fraction of suitable habitat surveyed to obtain an estimate of total sites in each type, and used an average occupancy rate from a subset of sites to extrapolate occupancy across the entire province. Estimates for suitable habitat and the percentages of suitable land surveyed for owls were derived from telephone interviews with landowners, timber company GIS layers and Timber Harvest Plan (THP) data, and a U.S. Forest Service report for National Forests. Due to the many untested assumptions and high amount of uncertainty in estimates, and the vague description of methods used, the report cannot be considered to provide a valid population estimate for the Klamath Province.

A recent study made use of the immense amount of data available on Northern Spotted Owl habitat requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity, dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the range of the owl (Schumaker et al. 2014). In addition to an evaluation of source-sink dynamics, outcomes of the model included a range-wide population size estimate, and the proportion of the population in each modeling region and physiographic province noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). Estimates of regional population sizes indicate that Northern Spotted Owls are most abundant in parts of southern Oregon and northern California (Table 5). The three California provinces were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population. The model indicated that the Klamath region is a stronghold for the population, with 50.1 percent cumulatively within the Oregon Klamath and California Klamath provinces, and 37.1 percent within the Klamath East and Klamath West modeling regions. Schumaker et al. (2014) estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions. Although informed by the best available data to develop an impressive assessment of source-sink dynamics across the range, the complexity of the model may limit its ability to accurately model population estimates. For example, differences in the simulated number of owls versus the numbers observed in eight demographic study areas used for calibration ranged from 5 to 47 percent (Schumaker et al. 2014). Nevertheless, the results suggest that California’s population of Northern Spotted Owls is an important component of the range-wide population.

Comment [ABF50]: This was a good point that I also tried to echo in my General Comment 1 under the STATUS AND TRENDS IN CALIFORNIA section

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1206 **Table 5.** Percent of range-wide Northern Spotted Owl population within modeling region and physiographic
1207 province based on simulation models (adapted from Table 2 in Schumaker et al. 2014).

Modeling Region	Percent of Population	Physiographic Province	Percent of Population
North Coast Olympics	0.1	Washington Western Cascades	1.3
West Cascades North	0.1	Washington Eastern Cascades	1.6
East Cascades North	3.3	Washington Olympic Peninsula	>0.0
West Cascades Central	1.2	Washington Western Lowland	>0.0
Oregon Coast	1.0	Oregon Eastern Cascades	3.5
West Cascades South	15.3	Oregon Western Cascades	23.3
Klamath West	20.0	Oregon Coast	0.8
Klamath East	17.1	Oregon Willamette Valley	>0.0
Redwood Coast	16.4	Oregon Klamath	13.7
East Cascade South	3.8	California Coast	16.6
Inner California Coast	21.7	California Cascades	2.8
		California Klamath	36.4

1208

1209 Most surveys for Northern Spotted Owls have been conducted on areas proposed for timber
1210 management activities in order to assess the potential for impacting the species, or on demographic
1211 study areas throughout the subspecies range. Although not designed for estimating density or
1212 abundance, pre-harvest surveys have dramatically increased knowledge on location of territorial owl
1213 sites (i.e., activity centers). As survey effort has expanded to new areas over time, the number of known
1214 activity centers has naturally increased. Although owls will shift activity centers over time, they exhibit
1215 high site fidelity to general nesting and roosting areas (Gutiérrez et al. 1995, Blakesley et al. 2006),
1216 therefore the increase in number of activity centers over time is more likely a result of expanded survey
1217 effort than establishment of new activity centers. In addition, across most of the Northern Spotted Owl
1218 range establishment of new nesting and roosting habitat that is suitable for supporting an activity center
1219 is a slow process given tree species growth rate, and so a rapid increase in the number of activity
1220 centers due to colonization of new habitat is unlikely. The possible exception to this is on the redwood
1221 coast where Northern Spotted Owls have been shown to select relatively young forests (41-60 years old)
1222 for nesting and roosting, as long as all habitat requirements are present (Thome et al. 1999). For
1223 example, Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a
1224 portion of their property that is completely surveyed each year and attributes this at least in part to
1225 improving habitat conditions as forests mature (GDRC 2015). The number of newly established activity
1226 centers across the range as a result of newly available nesting and roosting habitat is unknown. See the
1227 discussion on habitat changes in the threats section for additional information on the topic of habitat
1228 recruitment. The Humboldt Redwood Company has also reported an increase in number of sites since
1229 2008 (HRC 2015). A concurrent increase in detections of Barred Owls in heavily surveyed areas suggests
1230 that the increase in Spotted Owl activity centers is likely due at least in part to increased survey effort
1231 (see Figure 28 in the Threats section of this report). However, it is possible that the increase in Spotted
1232 Owl activity centers is due to the movement of Spotted Owls as a result of displacement by an
1233 increasing number of Barred Owls (HRC 2015) or displacement from lands that are no longer suitable
1234 due to timber harvest or wildfire.

Comment [ABF51]: Another point is that territories are also dynamic across the landscape as forests age.

Comment [ABF52]: Incomplete sentence

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In California, the number of known Northern Spotted Owl activity centers rapidly increased starting around 1990 when listing under the federal Endangered Species Act resulted in a widespread increase in survey effort (Figure 3). Through 1989, there were 1,366 Northern Spotted Owl activity centers in California. By the year 1999, this number had increased to 2,799. As of 2014, the number of Northern Spotted Owl activity centers was 3,116. The number of occupied activity centers in any given year is unknown because not all areas have been or can be surveyed on an annual basis (USFWS 2011a). It is likely that many of the known sites are unoccupied because of habitat loss due to timber harvest or severe fires, displacement by Barred Owls, or other factors, therefore much of the data from early survey reports are outdated and of little use in addressing population abundance or distribution questions (Courtney et al. 2004). For these reasons and for the sampling reasons discussed above, the number of activity centers does not represent an index of abundance but rather the cumulative number of territories recorded (USFWS 2011a).

Demographic Rates

“Because the existing survey coverage and effort are insufficient to produce reliable range-wide estimates of population size, demographic data are used to evaluate trends in Spotted Owl populations” – USFWS (2011a).

The U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) initiated eight long-term demography studies within the range of the Northern Spotted Owl during the years 1985 to 1991 in order to provide data on the status and trends of Spotted Owl populations, and to inform the effectiveness of the NWFP on federal lands (Lint et al. 1999). Additional demographic study areas that were not established under the NWFP have also been initiated. The additional study areas that are currently active include one entirely on private land (i.e., Green Diamond Resource Company), one on the Hoopa Indian Reservation land, and one composed of a mix of federal, private, and state lands (i.e., Rainer). The study areas range between Washington and northern California, and collectively represent about 9% of the range of the Northern Spotted Owl (Forsman et al. 2011; Figure 7).

These eleven study areas have been monitored annually since inception with an average of 19 survey years across all areas (Table 6). On each study area, territorial owls are captured and banded, followed by annual attempts to recapture or resight owls and to evaluate reproductive success of territorial pairs. Standard protocols ensure consistent and thorough attempts to band and resight territorial owls and to assess nesting status of territorial females (Anthony et al. 2006). Over the period of 17-24 years (depending on study area), a total of 5,224 non-juvenile owls have been marked in the eleven study areas with a total of 24,408 annual captures/recaptures/resightings, allowing for robust estimates of survival. The number of young produced by territorial females was determined in 11,450 separate cases (Forsman et al. 2011). Three study areas are located in California, representing a diverse land ownership; the Northwest California study area (NWC) is primarily on federal land, the Green Diamond Resource Company study area (GDR) is on private land, and the Hoopa Indian Reservation study area (HUP) is on tribal land. These three study areas cover approximately 6% of the range of the Northern Spotted Owl in California (based on the USFWS range). The GDR study area is entirely within the California Coast Province, the HUP study area is located on the western edge of the California Klamath Province, and the

Comment [ABF53]: This is a little confusing because most of these study areas are still ongoing and providing information on population trends

Comment [ABF54]: See also Franklin, A. B., D. R. Anderson, E. D. Forsman, K. P. Burnham, and F. W. Wagner. 1996. Methods for collecting and analyzing demographic data on the northern spotted owl. *Studies in Avian Biology* 17:12-20.

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NWC study area is mostly in the Klamath Province with a small portion in the Coast Province. There is no demographic study area in the California Cascades Province.

Table 6. Descriptions of 11 demographic study areas used to assess vital rates and population trends through 2008. Adapted from Table 1 and Appendix A in Forsman et al. (2011).

Study Area	Acronym	Years	Area (km ²)	Ownership
<i>Washington</i>				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
<i>Oregon</i>				
Coast Ranges*	COA	1990-2008	3,922	Mixed
H.J. Andrews*	HJA	1988-2008	1,604	Federal
Tyee*	TYE	1990-2008	1,026	Mixed
Klamath*	KLA	1990-2008	1,422	Mixed
South Cascades*	CAS	1991-2008	3,377	Federal
<i>California</i>				
NW California*	NWC	1985-2008	460	Federal
Hoopla Tribe	HUP	1992-2008	356	Tribal
Green Diamond	GDR	1990-2008	1,465	Private

*Indicates the eight study areas that are part of the federal monitoring program for the northern spotted owl.

Data from the demographic study areas have been compiled and analyzed regularly, with the most recent analysis covering all survey years through 2008 (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011). Demographic rates are estimated for each study area, and for all study areas combined (meta-analysis). An additional meta-analysis of data from the demographic study areas is ongoing and will include data through 2013. This additional information should provide further insight into important demographic rates across the species range. As discussed above, data collected from existing surveys are not sufficient to estimate population sizes, and so population trends cannot be assessed by comparing estimates of population size over time. However, the consistent collection of large amounts of capture/recapture data and observations of reproductive effort has resulted in an enormous amount of information which allows for estimation of vital rates across much of the range of the Northern Spotted Owl. When sufficient data is available, examination of demographic trends in survival and reproduction is one of the most reliable methods of assessing the health of a population. These data also allow for estimation of the annual rate of population change, lambda (λ), which reflects changes in population size resulting from reproduction, mortality, and movement into and out of a study area. Lambda does not provide a numerical estimate of population size, but instead estimates the proportional change in a population over a set period of time.

In addition to the coordinated analysis of data from all demographic study areas that occurs every 5 years, reports are available from individual study areas. Results from these reports are included in the discussion below when they offer more current information on the three California study areas than the most recent coordinated meta-analysis of 2011.

Comment [ABF55]: But the Southern Cascades study area is just across the border in OR; should probably note that.

Comment [ABF56]: This is confusing since most of these studies are still ongoing. Maybe retitle this column as Years used for Estimates? These time periods will change when the new meta-analysis comes out, which currently is in press.

Comment [A57]: Note to external reviewers: Where more recent data on demographic rates are available, either through annual reports or through presentations that have been publicly available, we include results as appropriate. We will update this report to include full results of the ongoing meta-analysis if the full publication becomes available prior to finalizing this status review.

Comment [ABF58]: See my General Comment 2 under the STATUS AND TRENDS IN CALIFORNIA section

Comment [ABF59]: This would be better defined as the rate of change in a population from one time step to the next (for annual rates, the time step would be from one year to the next)

Comment [ABF60]: The meta-analysis actually took place in 2009 and was not published until 2011.

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1299 *Rate of Population Change*

1300 A primary goal of the large scale monitoring at the demographic study areas and the regular coordinated
1301 analysis of data is to monitor population trends of the Northern Spotted Owl through estimation of
1302 lambda (λ , defined as annual finite rate of population change) (Anthony et al. 2006, Forsman et al.
1303 2011). A λ of 1.0 indicates that a population is stationary, whereas values greater or less than 1.0
1304 indicate increasing or declining populations, respectively. The most recent meta-analysis for all eleven
1305 study areas produced a weighted mean λ of 0.971 (standard error = 0.007, 95% confidence interval =
1306 0.960 to 0.983), corresponding to an average rate of population decline of 2.9% per year from 1985 to
1307 2006 (Forsman et al. 2011). Estimates of λ were below 1.0 for all 11 individual study areas, and ranged
1308 from 0.929 to 0.996 (Table 7). Population declines were most pronounced in Washington and the Coast
1309 Ranges of Oregon. The 95% confidence intervals do not overlap 1.0 for seven of the study areas,
1310 indicating strong evidence for population decline on these seven study areas. Although this study area-
1311 level demographic analysis did not show evidence for declines at KLA and CAS study areas, a territory-
1312 based study conducted in the Klamath Mountains and Cascade Range of southwest Oregon showed
1313 evidence for declining populations by 1996 (Dugger et al. 2005). In California, populations at GDR and
1314 NWC have declined, with estimates of λ of 0.972 for GDR (2.8% decline per year) and 0.983 for NWC
1315 (1.7% decline per year).

1316 In a more recent analysis of the available data, Franklin et al. (2015) reported a λ of 0.976 (1985-2013;
1317 95% CI 0.953-0.998) for the Willow Creek Study Area (part of the NWC study area). This shows an
1318 accelerated rate of decline (2.4% decline per year) compared to that reported by Forsman et al. (2011)
1319 for NWC. As reported in Forsman et al. (2011), the 95% confidence interval for HUP overlapped 1.0, so
1320 the study could not conclude that this population was declining through 2008. However, Higley and
1321 Mendia (2013) reported a λ of 0.977 (1985-2012; SE = 0.01; 95% CI 0.958-0.996) equating to a 2.3%
1322 population decline per year through 2012. This is the first time that the 95% CI for HUP does not include
1323 1.0, providing strong evidence that all three study areas in California now have declining populations of
1324 owls.

1325

Comment [ABF61]: You need to be careful about making these comparisons (see my General Comment 3 under the STATUS AND TRENDS IN CALIFORNIA section).

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Table 7. Demographic parameters for the Northern Spotted Owl demographic study areas through the year 2008. Adapted from Table 22 in Forsman et al. (2011) and Table A-1 in USFWS (2011).

Study Area	Fecundity	Apparent Survival ¹	Lambda (λ)	Population Change ²
<i>Washington</i>				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
<i>Oregon</i>				
Coast Ranges	Increasing	Declining	0.966	Declining
H.J. Andrews	Increasing	Declining	0.977	Declining
Tyee	Stable	Declining	0.996	Stationary
Klamath	Declining	Stable	0.990	Stationary
South Cascades	Declining	Declining	0.982	Stationary
<i>California</i>				
NW California	Declining	Declining	0.983	Declining
Hoopa	Stable	Declining	0.989	Stationary
Green Diamond	Declining	Declining	0.972	Declining

¹ Apparent survival calculations are based on model average.

² Population trends are based on estimates of realized population change.

Conversion of estimates for λ to estimates of realized population change (i.e., the proportional change in estimated population size relative to population size in the initial year of analysis) revealed dramatic declines in regional population sizes (Forsman et al. 2011). The study areas in the northern portion of the range showed precipitous declines, with populations in the Olympic, Cle Elum, and Rainier study areas in Washington and the Coast Range study area in Oregon estimated to have declined by 40 to 60% during the study period (Forsman et al. 2011). At a rate of decline of 2.9% per year, the total population of Northern Spotted Owls across all study areas would have declined by nearly 50% over the 22 years included in the study. Although the 95% confidence intervals for estimates of realized population change slightly overlapped zero, two study areas in California (NWC and GDR) showed estimated population declines of about 20% during the period of study. Using the revised estimate of λ for NWC through year 2013 (Franklin et al. 2015) would result in a larger estimated population decline for NWC. The other study area in California (HUP), showed a slight decline in population size at the end of the study period in 2008, but the 95% confidence interval broadly overlapped zero. Again, using more recent data such as those reported by Higley and Mendia (2013) would provide stronger evidence for a population decline at HUP.

Although the meta-analysis assessing vital rates on all demographic study areas through 2013 is ongoing, preliminary meetings held to coordinate data compilation and analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; the average rate of population decline per year on the eleven demographic study areas has been 3.8% per year (Dugger et al. in review, Higley and Mendia 2013), compared to a decline of 2.9% per year using data

Comment [ABF62]: Not sure why this reference is used here; does not seem to be relevant to the meta-analysis.

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through 2008 (Forsman et al. 2011). The ongoing analysis has revealed large changes becoming apparent in Oregon and California, with Northern Spotted Owl populations in California declining by 32-55% over the study period (1985-2013; Dugger et al. in review).

Fecundity and Survival

Fecundity (i.e., number of female young produced per adult female) and survival rates are estimated in order to inform estimates of λ , to determine the degree to which changes in these vital rates effect populations, and to model effect of potential explanatory variables on these important vital rates. The Northern Spotted Owl is a long-lived species, with relatively high adult survival rates, and with high variability in fecundity from year to year. Fecundity estimates varied across study areas and ranged from 0.230 to 0.553 female young produced per adult female (Forsman et al. 2011). Most Spotted Owls do not breed every year, but more normally breed every other year, which contributes to low fecundity in the species. There was evidence for declining fecundity on five areas, three areas were stable, and three areas showed increasing fecundity (Forsman et al. 2011). In California, fecundity showed declines on two areas (NWC and GDR) and was stable on one area (HUP), although HUP exhibited the lowest fecundity rate of all eleven study areas. Adult survival has declined on 10 of 11 study areas, with the Klamath study area in Oregon being the exception. Annual survival rate represents the probability that a bird that was alive in one year will be alive the following year, therefore a mean rate of 1.0 would indicate that all birds survive from one year to the next. Values of mean apparent adult survival for the entire study period range from 0.819 to 0.865, with declines most pronounced in Washington and Oregon. Apparent survival rates in Washington had been less than 80 percent in years leading up to 2008, a rate that is unlikely to allow for sustainable populations (Forsman et al. 2011). Although less severe than in Washington and much of Oregon, all California study areas show declines in survival (Table 7).

For most demographic study areas, changes in λ were driven mainly by changes in survival. This is consistent with the hypothetical expectation from a long-lived species with high variability in fecundity over time, and is also consistent with previous studies showing that annual rates of population change are most influenced by changes in adult survival (Noon and Biles 1990, Lande 1991, Blakesley et al. 2001). This is a concerning finding because survival was shown to be declining on 10 of 11 study areas across the entire range of the subspecies, including all three California study areas. In the previous demographic analysis analyzing data from 1985-2003 (Anthony et al. 2006), declines in adult survival in Oregon had not been observed and only one study area in California showed declines, therefore declines in survival in the southern portion of the range occurred predominantly in the most recent five years for which data were available (2004-2008). The overall assessment from the most recent demographic study (Forsman et al. 2011) is that reproduction and recruitment have not been sufficient to balance losses due to mortality and emigration, so many of the populations on study areas have declined over the two decades included in the study.

When the NWFP was implemented, it was assumed that Northern Spotted Owl populations would continue to decline for up to a few decades, but would gradually increase and eventually stabilize as

Comment [ABF63]: Be careful about making this comparison (see my General Comment 3 under the STATUS AND TRENDS IN CALIFORNIA section). Also, you need to include 95% CI for the point estimates if you are making these comparisons.

Comment [ABF64]: These are components of lambda but not the only ones (see my General Comment 4 under the STATUS AND TRENDS IN CALIFORNIA section). Thus, this statement is not completely accurate for current methods used to estimate lambda.

Comment [ABF65]: What is measured on most studies is "apparent annual survival" which is defined as the probability that a bird alive in one year survives and remains on the study area the following year. The difference here is that reciprocal of apparent survival includes both death and emigration from the study area.

Comment [ABF66]: See my General Comment 5 under the STATUS AND TRENDS IN CALIFORNIA section

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1389 habitat protection and successional processes increased available habitat on reserve lands (USDA and
1390 USDI 1994). To date, five meta-analyses have been conducted on data from Northern Spotted Owl
1391 demographic study areas, with results readily available for three of the analyses. A sixth analysis is
1392 ongoing and will include all survey years through 2013. In the second meta-analysis which summarized
1393 results through 1993 (Burnham et al. 1996), no trend in fecundity was detected and survival was shown
1394 to be declining among adult female owls; λ was less than 1.0 for most study areas. The fourth meta-
1395 analysis which covered data through 2003 (Anthony et al. 2006) found evidence for declining fecundity
1396 at six study areas (although 95% confidence intervals overlapped zero for all six areas), and strong
1397 evidence that survival was declining on four of 14 study areas included in the analysis (two of which no
1398 longer participate in the demographic analysis). Mean λ across all study areas was also less than 1.0 with
1399 an annual rate of population decline estimated to be 3.7%, although only four study areas had 95%
1400 confidence intervals for estimates of λ that did not overlap 1.0 (Anthony et al. 2006). The fifth and most
1401 recent meta-analysis covers data through 2008 (Forsman et al. 2011) and provides strong evidence for a
1402 decline in fecundity on 5 of 11 study areas and strong evidence for declining survival on 10 of 11 study
1403 areas. After two decades of NWFP implementation, it is clear that the declining Northern Spotted Owl
1404 populations have not stabilized, and estimates of demographic rates indicate that across much of the
1405 range, the decline has accelerated. This is evident in the declining populations on seven of the 11 study
1406 areas, only two of which showed strong evidence for decline in the previous analysis.

1407 In California, two of three study areas (NWC and GDR) in the recent analysis were shown to be
1408 experiencing declines in fecundity and all California study areas showed declines in survival (Forsman et
1409 al. 2011). The previous analysis also found evidence of declining fecundity on two California study areas
1410 but found evidence for declining survival on only one (Anthony et al. 2006). Although estimates of λ for
1411 study areas in California are not as low as those in Washington and northern Oregon, negative trends in
1412 vital rates had led to population declines on at least two of three California study areas by 2008 (NWC
1413 and GDR). The decline at the NWC study areas had apparently not begun by 1994 (Franklin et al. 2000).
1414 Although Northern Spotted Owls at the southern portion of the range appear to have been temporally
1415 buffered from population declines, the ongoing and accelerating decline in demographic rates had
1416 affected populations in California by 2008.

1417 Most of the demographic study areas were established to evaluate the effectiveness of the NWFP and
1418 consist of federal lands or a mix of federal and nonfederal lands. Although not randomly chosen,
1419 Forsman et al. (2011) suggests that results from the demographic study areas are representative of
1420 federal lands and areas of mixed federal and private lands throughout the range of the Northern
1421 Spotted Owl because “the study areas were (1) large, covering about 9% of the range of the subspecies;
1422 (2) distributed across a broad geographic region and within most of the geographic provinces occupied
1423 by the owl; and (3) the percent cover of owl habitat was similar between our study areas and the
1424 surrounding landscapes”. The authors expressed less confidence that study areas reflected trends on
1425 non-federal lands because the two study areas consisting mainly of non-federal lands (GDR and HUP)
1426 are near the southern edge of the subspecies’ range and both are actively managed for Spotted Owl
1427 habitat. These two non-federal study areas might not accurately represent other non-federal lands in
1428 California because of the management mentioned above and because they are located in the California

Comment [ABF67]: But see my General Comment 2 under the STATUS AND TRENDS IN CALIFORNIA section

Comment [ABF68]: What about the 3rd meta-analysis?

Comment [ABF69]: see my General Comment 3 under the STATUS AND TRENDS IN CALIFORNIA section

Comment [ABF70]: This statement implies that the NWFP is not working but factors controlled by the NWFP (e.g., habitat) have since been confounded by increasing populations of barred owls.

Comment [ABF71]: Which also coincided with increasing numbers of barred owls

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Coast and western edge of the California Klamath physiographic provinces, and may not accurately represent conditions in other parts of the California range, especially the California Cascades. The authors suggested that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands (Forsman et al. 2011).

Although results from the ongoing meta-analysis for the eleven demographic study areas are not yet available, recent reports from individual study areas in California (NWC, HUP, and GDR) provide information on current estimates for reproductive success and survival. At GDR, reproductive success (number of young fledged per monitored site) showed a negative trend from 1992-2014 (regression slope = -0.014), with a mean of 0.54 during this time period (GDRC 2015). This is a different metric of fecundity than used in the most recent demographic analysis (Forsman et al. 2011; number of female young produced per adult female), but shows a continuing decline in productivity since 2008. On HUP, mean reproductive rate (young fledged per monitored female; also a different measure of fecundity) from 1991-2013 was 0.42 with a range of 0.05 to 1.04 (Higley and Mendia 2013). During 2011, 2012 and 2013 HUP showed unusually low reproductive rates of 0.05, 0.13, and 0.06, respectively. In 2013, adult survival was approximately 0.8 on HUP (Higley and Mendia 2013), which is lower than that reported by Forsman et al. (2011). Annual apparent survival for territories surveyed on NWC averaged 0.848 for 1985-2014 (Franklin et al. 2015). Reproductive rate has also been reported for private timberlands outside of the demographic study areas, although monitoring and analysis approaches are not standardized as in the eleven demographic study areas, so direct comparisons are not possible. Humboldt Redwood Company reported a reproductive rate (number of young per pair) of 0.49 in 2014 (HRC 2015) and Mendocino Redwood Company reported a reproductive rate of approximately 0.12 in 2014 (MRC 2014). HRC (2013) noted a drop in reproductive rate since 2009. These more recent estimates of reproductive rate and survival since the last demographic meta-analysis (Forsman et al. 2011) are consistent with a continued decline within the demographic study areas in California.

As mentioned in the Life History section, most Spotted Owls do not breed every year and annual variation in reproductive effort and success is thought to be related to local weather conditions and fluctuations in prey abundance. This results in most areas having high variation in reproductive success between good years and bad years and can be seen in modeled rates of fecundity (Forsman et al. 2011). In the coastal portion of the Northern Spotted Owl range in California, many areas reported consistently low reproductive success from 2011-2013, including some of the lowest reproductive success rates on record in 2013. This is despite weather conditions in 2013 that would typically support good reproductive success. This was observed on many timber company lands (Calforests 2014, HRC 2014, GDRC 2015), tribal lands (Higley and Mendia 2013), and National Park land (Ellis et al. 2013). The reason for this widespread pattern of low reproductive success is not known.

In addition to providing rigorous estimates of survival, productivity, and population change across much of the range of the Northern Spotted Owl, the large amount of data and the regular demographic analyses allow for investigation of potential associations between population parameters and covariates that might explain estimates and trends (Forsman et al. 2011). Potential explanatory variables included in modeling during the most recent analysis of fecundity, survival, and λ included multiple weather and climate covariates, a habitat covariate, a Barred Owl covariate, and several other broad geographic

Comment [ABF72]: But keep in mind that all of these different metrics are highly correlated (i.e., fecundity \approx 1/2 number of young fledged/site

Comment [ABF73]: Franklin et al. 2015 also reported low reproduction for 2011 and 2012 (see their Table 6)

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covariates. Unlike studies that have modeled vital rates and potential explanatory variables at the scale of individual owl territories (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005), the meta-analysis evaluates covariates as an average effect across large study areas. The Barred Owl covariate was evaluated as the proportion of Northern Spotted Owl territories in each study area that had Barred Owls detected within a 1-km (0.62 mi) radius of activity centers. The habitat variable was the proportion of “suitable habitat” (based on Davis and Lint (2005), but generally characterized as containing large overstory conifers (dbh > 50cm) and canopy closure >70% in the study area). Although modeling average effect across large study areas is not as powerful at detecting effects that are influential at the territory scale (e.g., presence of Barred Owl or habitat conditions), data limitations required a coarser evaluation at the broad scale of the demographic analysis in order for methods to be consistently applied across study areas (Forsman et al. 2011). The broad demographic analysis found relatively weak associations between the amount of habitat and demographic rates, and somewhat larger effects of Barred Owl. These results, and those from more powerful territory-based studies, are discussed in the Habitat Requirements section and in the Threats section of this report.

Comment [ABF74]: Could couch as a “subpopulation scale”

Occupancy

Occupancy data are less resource-intensive to collect compared to data required to estimate the demographic parameters discussed above. Estimation of survival and reproduction requires the capturing and banding of owls at known sites, and multiple annual visits to all sites in order to recapture or re-sight owls, and to determine reproductive status. Occupancy data is based on the presence or absence of owls from known sites, and depending on the objectives of the monitoring does not necessarily require the monitoring of all sites each year. Due to this reduced requirement in survey effort and the necessity to visit known owl sites during pre-timber harvest monitoring, this type of data has frequently been collected and reported by timber companies and by other landowners (e.g. National Parks).

Comment [A75]: Note to external reviewers: The ongoing demographic analysis covering all survey years through 2013 will include occupancy modeling for the first time. Though we have included some preliminary results in this report when available (cited as “Dugger et al. in review”), we will update prior to finalizing if the full publication becomes available.

Although occupancy might appear to provide a substitute for estimates of survival, reproduction, or the rate of population change, it is not always appropriate to use an apparently stable occupancy rate to suggest a stable population size. As explained by Forsman et al. (1996),

“...it is possible that in a declining population, observed densities of territorial owls might not change during early years of the decline simply because territorial owls that died could be replaced by floaters (owls without territories) (Franklin 1992). Thus, significant changes in density of territorial owls might not become apparent for many years, especially if the rate of population decline was small (e.g., 1-2% per year).”

Therefore, a lack of a significant decline in observed owl numbers cannot necessarily confirm or refute estimates of survival or λ . Although little is known about the floater population of Northern Spotted Owls at any study area, other than that they exist and that they do not readily reply to broadcast calling, the number of floaters is finite. The perception of population stability due to establishment of territories by floaters cannot continue indefinitely in a constantly shrinking population. Depending on the rate of population decline (λ), the phenomenon should gradually disappear as the floater population is

Comment [ABF76]: But if number of territorial owls does not decline, this will also be reflected in estimates of λ ; recruitment from a declining pool of floaters would also buffer declines.

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depleted. If a study area has a relatively robust population of floaters, or if emigration into the study area occurs, the local population can decline for some time before being detected through declines in occupancy. Although declines in occupancy can indicate a reduction in local abundance when survey efforts are consistent over time (Bigley and Franklin 2004), a stable occupancy rate may not necessarily indicate that a population is stable.

Higley and Mendia (2013) observed inflated rates of occupancy on the Hoopa Valley Indian Reservation, and suggested that if owls are not color banded, it may be difficult to interpret stable occupancy rates. The authors believe that inflation of observed occupancy rates may be more likely in areas where Barred Owls are present and displace Spotted Owls:

“Furthermore, because our owls are color banded, we know that they are being observed in more than one territory per season... They are moving vast distances (several miles). Due to this movement, we may be seeing an inflated occupancy (use) rate on the landscape that is well above the actual rate. If this behavior exists in study areas without color-banded owls, there would be no way to determine whether owls in multiple sites were in fact the same individual.”

Although an evaluation of occupancy rates has not been included in previous demographic analyses, the authors of the most recently completed analysis note that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning, and few territorial owls could be found on some of the study areas in 2008 (Forsman et al. 2011). This is an important consideration in interpreting results of the demographic analysis because estimates of fecundity and survival rates are independent of population size. The estimated rates are averages for all owls in a study area and so do not incorporate any measure of population size. If a study area experiences a declining number of territorial owls, which on average are experiencing reductions in rates of fecundity, the result will be far fewer owls produced each year. Even if Northern Spotted Owls at a given study area experience stable rates of fecundity over time, areas with declining occupancy rates will produce fewer young overall. This phenomenon might also explain the relatively weak effect of Barred Owls on fecundity at some study areas (see discussion of Barred Owl in Threats section). If Northern Spotted Owls become displaced by Barred Owls, they are less likely to be detected (either because of increased mortality or because they are non-territorial and non-responsive to calls). Any Northern Spotted Owls not displaced may continue to breed at historic levels, resulting in no detectable reduction in fecundity on average, or they may breed at some unknown level in sub-prime habitat and remain undetected. However, the net effect is that fewer Northern Spotted Owls are produced (Forsman et al. 2011).

In order for estimates of occupancy to be valid, survey efforts must be consistent over time and the detection probability (the probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead to high variation in detection probability which can skew estimates of occupancy if not accounted for. Ideally the owl population would also be banded in order to address the concern of inflated occupancy rates observed by Higley and Mendia (2013), at least in areas where Barred Owl is present. The ongoing demographic analysis using data from the eleven demographic study areas and covering all survey years through 2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have declined at all three California study areas, with 32-

Comment [ABF77]: This violates the closure assumption of occupancy estimation. It could be resolved if movement is better understood (e.e., does it occur later in the season?) and accounted for in sampling.

Comment [ABF78]: This sentence did not make sense. Mortality and detection are two independent events (dead owls obviously cannot be detected during surveys).

Comment [ABF79]: Also have to meet the within-season closure assumption.

Comment [ABF80]: Would this be because presence of barred owls would increase movement? If so, should state that.

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1546 37% declines from 1995–2013 (Dugger et al. in review). All demographic study areas in Washington and
1547 Oregon have also experienced declines in occupancy, which is consistent with previous reports from
1548 these areas (Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011, Davis et al. 2013). Occupancy rates in
1549 Washington have declined by as much as 74% (Dugger et al. in review). Occupancy rates are a balance
1550 between rates of local territory extinction and rate of colonization. Barred Owls were shown to have a
1551 strong effect on occupancy by increasing the local territory extinction rate (Dugger et al. in review).
1552 There is also some evidence of that Northern Spotted Owl will not reoccupy empty sites if Barred Owls
1553 are present. Preliminary results also show a positive effect of habitat on colonization rates, and a
1554 negative effect of habitat in the core area on extinction rates (i.e. less habitat in the core area leads to
1555 higher extinction rate) (Dugger et al. in review).

1556 Outside of the three California demographic study areas, studies that have compiled robust datasets
1557 suitable for evaluation of Spotted Owl site occupancy in California are rare. In the southern Cascades
1558 and interior Klamath provinces of California, where there are no demographic study areas, Farber and
1559 Kroll (2012) compiled data from 1995–2009 using a consistent and rigorous annual survey effort at 63
1560 Northern Spotted Owl sites. Occupancy modeling showed that simple and pair Spotted Owl occupancy
1561 probabilities declined approximately 39% over the 15 year period; site occupancy for any owl declined
1562 from 0.81 (0.59–0.93) to 0.50 (0.39–0.60), and pair occupancy declined from 0.75 (0.56–0.87) to 0.46
1563 (0.31–0.61). In addition to providing estimates of occupancy from the interior of the range in California
1564 that is relatively understudied, this study also provides a rigorous assessment of occupancy trends on
1565 private timberlands.

1566 As an example of declining populations at California demographic study areas, the number of observed
1567 owls on NWC has declined from a high of 195 owls in 1992 to low counts of 62–67 owls since 2012
1568 (Franklin et al. 2015). At HUP, the number of owls observed between 1992 and 2006 was between 60–70
1569 owls each year; a steep decline since then has resulted in only 30 owls observed in 2013 (Higley and
1570 Mendia 2013). At the GDR density study area, the number of occupied sites declined from about 120–
1571 140 sites for years 1992–2004 to just over 80 occupied sites in 2008 (exact numbers not available; GDRC
1572 2015). A partial recovery in number of occupied sites led to about 110 occupied sites by 2012; the
1573 authors attributed this increase to removal of Barred Owls and an increase in suitable habitat (GDRC
1574 2015). Several study areas north of California have also undergone dramatic declines.

1575 In the 97,000 acre Redwood National and State Parks, as many as 40 Northern Spotted Owl activity
1576 centers were identified during the 1990s. Occupancy rates are not available for the parks. However, by
1577 2001 a large proportion of activity centers had become inactive, and subsequent intensive surveys
1578 revealed that most historical Spotted Owl territories now appear to be occupied by Barred Owls
1579 (Schmidt 2013). Data through 2012 indicated that at least 58 Barred Owl sites occurred within the parks,
1580 not including areas with single detections of Barred Owls. In 2012, Northern Spotted Owls were
1581 detected at just four territories in the parks, with only one pair observed; this was also the second
1582 consecutive year with no known reproduction of Northern Spotted Owl in the parks (Schmidt 2013).

1583 In contrast to the above studies at demographic study areas and at other well-monitored areas that
1584 showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the

Comment [ABF81]: I assume this was taken from Table 3 in the report. However, these numbers are just birds identified not total number of birds encountered and also includes juveniles. I would not use these numbers to reflect population changes.

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study area, several industrial timber companies have concluded that Northern Spotted Owl occupancy rates have been stable on their lands, and that this indicates stable populations (Calforests 2014). In 2014, the California Forestry Association hosted a Northern Spotted Owl Science Forum, to which members of the association were invited to present on monitoring efforts and status of Spotted Owls on their property. Twelve landowners, timber management companies, and non-profit groups presented on various aspects of timber operations as they relate to Northern Spotted Owls. Presentations included data on Northern Spotted Owl surveys, numbers, and population parameters, although the information presented varied by participant. Reports on estimated occupancy rates were included in many presentations and are summarized in Table 8 for nine companies.

As discussed above, valid estimates of occupancy require consistent survey efforts over time, and modeling of occupancy rate must take into account detection probability. These requirements were rarely met in the occupancy estimates and trends reported by the timber companies (Calforests 2014). There is no standardized monitoring protocol used across the timber companies, and methods employed have been highly variable. In some cases, the level of detail at which methods are described does not allow for evaluation of occupancy estimates.

Of nine companies reporting on some aspect of occupancy on their ownership, five reported a stable trend in occupancy with one company reporting that the population size is variable. Two companies reported a mix of stable, declining, or increasing occupancy, depending on the time period or the portion of the owl population assessed. In most cases the companies have reported on counts of occupied sites or on naïve estimates of occupancy (the proportion of surveyed sites that are occupied in a given year) without consideration of detection probability. Counts of occupied sites and detection probability are both dependent on survey effort. An example of this can be seen in data submitted by Mendocino Redwood Company, which shows a correlation between survey effort and estimates of occupancy.

Green Diamond Resource Company, as a participant in the rangewide coordinated demographic studies since 1990, has the longest history of banding and monitoring work among the companies. Results from Green Diamond Resource Company are included in the demography section. Although results on occupancy modeling are preliminary, modeling revealed a more than 30% decline in occupancy from 1995-2013 (Dugger et al. in review). A reduction in the rate of decline in recent years was attributed to the removal of Barred Owl from portions of the study area.

Humboldt Redwood Company also has a fairly long history of monitoring, with consistent methods being used since 2002 and banding being conducted since 2003 as part of the HCP monitoring program (HRC 2014). Monitoring under the Humboldt Redwood Company HCP samples a subset of the land ownership in each year. Twenty percent of lands are surveyed each year, with the entire property surveyed every five years. However, core sites are monitored annually, including determination of occupancy, whereas other sites are sampled on a rotating basis. Core sites were established to represent activity centers that have had a history of occupancy and reproduction, and the HCP provides higher habitat retention requirements for these core sites. Therefore, sites which are monitored annually are those which meet minimum habitat requirements and have a higher history of use by Northern Spotted Owl, resulting in a

Comment [ABF82]: Incorporating detection probability would only make the estimates similar or higher; modeled estimates of occupancy should always be similar or higher to naïve estimates). I would be more concerned about whether lack of the closure assumption (i.e., within-season movements of birds among sites) positively biased estimates.

Comment [ABF83]: Positive or negative correlation?

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biased sample. The sampling scheme therefore results in biased estimates of occupancy for the ownership as a whole. Also, because the non-core sites are sampled on a rotating basis, a different set of sites is sampled each year. It is unclear how this rotating sampling scheme may affect reported trends in occupancy. The sampling scheme included in the Humboldt Redwood Company HCP has the benefits of less intensive annual survey requirements and the ability to focus survey effort on sites with upcoming timber harvest or other management actions in order to meet the requirements of the HCP, but limits the ability to accurately determine occupancy rate for the ownership as a whole.

Campbell Global, L.L.C. manages timber lands for multiple owners, and reported on occupancy rates for two ownerships in Mendocino County (Calforests 2014). All known active activity centers were surveyed annually to determine occupancy status. Occupancy was first presented using simple count data for years 2000-2013, with no apparent trend in occupancy over time. The Spotted Owl population was reported to be dynamic but stable on these ownerships. Campbell Global also presented preliminary results of modeled occupancy dynamics (including estimation of detection probability) using data from the same ownerships from 1990-2010. Modeling showed that occupancy probabilities for single Spotted Owls began to decline in 2003. Pair occupancy declined by 16-30% during the initial portion of the time period before stabilizing in 1997. These results show how simple counts or naïve estimates of occupancy will not necessarily reflect true occupancy rates.

The Mendocino Redwood Company is the only other company to model occupancy rates taking into account detection probability (Calforests 2014). As with the lands managed by Campbell Global, L.L.C., when occupancy was presented using counts or naïve estimates there was no apparent trend (years included were 2001-2013). However, when occupancy modeling was conducted for a subset of years 2001-2008, a slight decline in occupancy was found. Occupancy modeling was not conducted on data from more recent years.

The variability in methods used by companies, the tendency to report on counts or naïve estimates of occupancy without consideration of detection probability, the sometimes inconsistent methods used over time, along with the sometimes limited description of methods, makes it difficult to interpret the reported occupancy rates and trends for most companies. This leads to some difficulty in comparing reported rates in timber company reports to other published estimates of occupancy and does not support a strong finding that occupancy rates have been stable across these ownerships over time.

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1654 **Table 8.** Occupancy estimates as presented in the Northern Spotted Owl Science Compendium in 2014 by
1655 participating timber companies with ownership in the range of the Northern Spotted Owl in California. See text for
1656 caution in interpreting these results.

Company	Pair Occupancy in 2013	Reported Occupancy Trend
Humboldt Redwood Company (Humboldt County)	0.85 (pairs only)	Stable
Sierra Pacific Industries (mainly Siskiyou and Shasta counties)	No rate provided, reported 48 known sites occupied	Stable
Conservation Fund (Mendocino and Sonoma counties)	No rate provided, reported 23 known sites occupied	Stable
Michigan-California Timber Company (Siskiyou County)	0.48	Stable
Green Diamond Resource Company (Humboldt and Del Norte counties)	0.83	1998-2008 Declining 2009-2011 Increase ¹
Crane Mills (mainly Tehama and Shasta counties)	No rate provided, reported 38 known sites occupied	No trend in occupancy noted
Mendocino Redwood Company (Mendocino and Sonoma counties)	0.69	Stable
Fruit Growers Supply Company (mainly Siskiyou County)	Approximately 0.95	Variable
Campbell Global (Mendocino, Siskiyou and Shasta counties)	>0.85 and >0.80 (singles) >0.85 and >0.70 (pairs) (estimates from 2010 occupancy analysis on two ownerships in Mendocino County)	Declining Stable

¹ The increase in occupancy starting in 2009 was attributed to the start of Barred Owl removals from the study area.

Source-Sink Dynamics

1660 Pulliam (1988) was the landmark publication on source-sink population dynamics. Since then,
1661 application of source-sink dynamics has been applied within many ecological studies to better
1662 understand movement (e.g., dispersal) interactions on the landscape while accounting for birth and
1663 death rates within population segments. Source populations are those in which reproduction exceeds
1664 carrying capacity thereby providing a surplus of individuals, whereas sink populations are those where
1665 mortality exceeds local reproduction (Pulliam 1988, Dias 1996, Watkinson and Sutherland 1995).
1666 Pseudo-sinks are populations that those populations that may be viable, but movement dynamics are
1667 difficult to distinguish based on complicated demographics and habitat connectivity (Watkinson and
1668 Sutherland 1995). These source-sink dynamics have been linked to habitat quality, generally with high

Comment [ABF84]: See my General Comment 1 under the STATUS AND TRENDS IN CALIFORNIA section

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quality habitat producing source populations, and low quality habitat producing sink populations (Dias 1996). Protected areas may serve different functions for vulnerable species depending on habitat quality and connectivity (Hansen 2011). Understanding source-sink populations can give us insight into appropriate and effective management actions that may benefit species habitat and populations at a local or range-wide level. For the Northern Spotted Owl, such principles are key to understanding connectivity (quality and function) between populations and how these populations may affect one another.

By applying source-sink modeling techniques and utilizing the immense amount of data available on Northern Spotted Owl life history and demography, Schumaker et al. (2014) characterized Northern Spotted Owl movement dynamics between modeling regions and physiographic provinces noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). For California, the Northern Spotted Owl populations within the Klamath region (Klamath West and Klamath East modeling regions; California Klamath physiographic province) and the Inner California Coast Range modeling region were identified as source populations, while the California Coast Range and California Cascade physiographic provinces were identified as sink populations (Table 9). Source-sink strength was substantial for the East Cascade South modeling region (sink), Klamath East region (source), Inner California Coast region (source), California Coast province (sink), and California Klamath province (source).

Table 9. Source and sink attributes within modeling region and physiographic province found in California (adapted from Table 2 in Schumaker et al. 2014). Includes percent of modeled range-wide population for each location, whether the location is a source or sink, and the strength of the sink/source as a percent of the best range-wide source or worst range-wide sink.

Location	Percent of population	Source or Sink	Source-Sink Strength
<i>Modeling Regions</i>			
East Cascade South	3.8	Sink	100
Redwood Coast	16.4	Sink	28.1
Klamath West	20.0	Source	51.1
Klamath East	17.1	Source	97.9
Inner California Coast	21.7	Source	100
<i>Physiographic Provinces</i>			
California Coast Range	16.6	Sink	100
California Cascades	2.8	Sink	35.9
California Klamath	36.4	Source	100

Schumaker et al. (2014) evaluated movement and contribution to overall population growth rate within modeling region and physiographic province source locations range-wide. Data for source locations in California is summarized in Table 10 and graphically in Figure 8. Klamath modeling regions (Klamath West and Klamath East) provided a flux of individuals within (e.g., Klamath West to Klamath East), and to the Cascade modeling regions (East Cascade South and West Cascades South), Redwood Coast, and Oregon Coast. Percent of net flux was most notable from Klamath East to East Cascade South regions. The Inner California Coast modeling region provided a flux of individuals to Klamath and East Cascade South regions. The California Klamath province was identified as a source provided a flux of individuals

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1699 to the California Coast Range, California Cascades and Oregon Klamath provinces, with net flux most
1700 notable to the California Coast Range province.

1701 **Table 10.** Net Flux and $\Delta\lambda^R$ for modeling region and physiographic province source locations in California (adapted
1702 from Table 3 in Schumaker et al. 2014). Net Flux represents movement from one location to another. $\Delta\lambda^R$
1703 represents the change in overall population growth rate.

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
<i>Modeling Regions</i>			
Klamath West	Redwood Coast	36.2	3.9
	Oregon Coast	49.5	45.9
	Klamath East	12.7	19.1
Klamath East	East Cascade South	100	85.1
	West Cascades South	36.0	27.4
Inner California Coast	Klamath West	44.4	28.3
	Klamath East	19.7	18.4
	East Cascades South	30.4	22.4
<i>Physiographic Provinces</i>			
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

1704
1705 Schumaker et al. (2014) results suggest that California's population of Northern Spotted Owls is a
1706 significant component of and source to the range-wide population. As a source, the Klamath region
1707 populations provide a source of owls to sink populations on the Coast and Cascade ranges. This concept
1708 is central to protection of owl habitat, especially dispersal habitat, for the continued persistence of
1709 Northern Spotted Owls across their range.

Existing Management

Land Ownership Patterns in Northern Spotted Owl Range

1713 The laws and regulations governing management of forests in the range of the Northern Spotted Owl
1714 vary depending on ownership. For this reason, the following discussion on existing management is
1715 partitioned based on ownership, with lands governed by a common set of regulations. In general,
1716 federal timberlands in the range of the Northern Spotted Owl are governed by the NWFP, with some
1717 federal ownership subject to more restrictive management (e.g., National Parks). Although tribal lands
1718 are subject to federal regulations for timber management, the tribes in the range of the Northern
1719 Spotted Owl in California have developed Forest Management Plans (FMPs) and are discussed
1720 separately. Nonfederal lands in California must comply with the Forest Practice Rules for commercial
1721 timber harvest. There are several options for complying with the Forest Practice Rules when developing
1722 a THP depending on several factors including, but not limited to, size of ownership, presence of Spotted
1723 Owl activity centers, and qualification for an exemption. We present these options below and discuss
1724 the most important options in greater detail.

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Federal lands contain less than half of the total forest land in the range of the Northern Spotted Owl (Mouer et al. 2011). Of an estimated 14.3 million acres of forested lands within the Northern Spotted Owl range in California, 6.4 million acres are publicly owned and 7.8 million acres are privately owned (2.3 million acres industrial and 5.5 million acres non-industrial) (Calforests 2013). Federal lands in the Northern Spotted Owl range in California are more concentrated in the interior portion of the range, with most USFS and BLM land occurring in the Klamath and Cascades provinces (Figure 9). The majority of the California Coast Province is under private ownership, though large tracts of public land occur along the coast, including both State and National parks. The most interior portion of the Northern Spotted Owl range in California (Cascades and eastern portion of Klamath provinces) has a combination of federal and private land, sometimes in a checkerboard pattern as a result of historical railway land grants (Figure 9). Tribal lands in California collectively represent 167,401 acres in the range of the Northern Spotted Owl and are mostly within the Coast Province and the western portion of the Klamath Province.

Critical Habitat Designation

In 2012, the USFWS revised the critical habitat designation for the Northern Spotted Owl (USFWS 2012). The purpose of critical habitat is to designate land distributed within the entire range of the Northern Spotted Owl that provides “features essential for the conservation of a species and that may require special management”, which includes forest types supporting the needs of territorial owl pairs throughout the year, including nesting, roosting, foraging, and dispersal habitat (USFWS website - <http://www.fws.gov/oregonfwo/species/data/northernspottedowl/CriticalHabitat/default.asp>). Critical habitat was identified using a modeling framework that considered both habitat requirements and demographic data, and considered uncertainties such as impacts of Barred Owl, climate change, and wildfire risk. Range wide, 9.29 million acres of critical habitat is on federal land and 291,570 acres is on state land. All private lands and the majority of state lands were excluded from the designation. A map of critical habitat for California is shown in Figure 10, which includes 2,014,388 acres on federal land, and 49,542 acres on state land. For management purposes, critical habitat only affects federal actions and do not provide additional protection on non-federal lands, unless proposed activities involve federal funding or permitting.

Federal Lands

Northwest Forest Plan

In the early 1990s, concern was raised regarding the adequacy of federal plans to protect the Northern Spotted Owl. Litigation resulted in a court injunction on harvest of owl habitat (mature and old-growth forest). In 1993, President Clinton directed the Forest Ecosystem Management Assessment Team (FEMAT) to develop long-term management alternatives for maintaining and restoring habitat conditions to maintain well-distributed and viable populations of late-successional- and old-growth-related species. The FEMAT was instructed to maintain and restore habitat conditions for the Northern Spotted Owl (as well as the Marbled Murrelet). The FEMAT was also instructed to maintain and restore

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habitat conditions to support viable populations, well-distributed across current ranges, of all species known or reasonably expected to be associated with old-growth habitat conditions; and to maintain or create a connected, interactive, old-growth forest ecosystem on federal lands (FEMAT 1993; Thomas et al. 2006). In developing alternatives, the members of FEMAT relied heavily on recently completed conservation assessments, including a regional conservation strategy for the Northern Spotted Owl (Thomas et al. 1990). The analysis of the FEMAT alternatives in a final supplemental environmental impact statement (USDA and BLM 1994a) led to adoption of the land-allocation strategy contained in the record of decision (USDA and BLM 1994b), hereinafter referred to as the Northwest Forest Plan. The NWFP amended nineteen existing USFS and seven BLM resource management plans within the range of Northern Spotted Owl. The intention of the NWFP is to improve current conditions and alter past practices that were detrimental to late-successional species by protecting large blocks of remaining late-successional and old-growth forests, and to provide for the regrowth and replacement of previously harvested late-successional forest stands. To help facilitate decision-making and issue resolution during the implementation of the NWFP, the Regional Ecosystem Office was formed and is made up of members from USFS, BLM, National Park Service (NPS), and Environmental Protection Agency (EPA).

The NWFP covers approximately 24 million acres of federal land within the range of the Northern Spotted Owl, about 67% of which are allocated in one of several “reserved” land use designations (see discussion of designations and Table 11). In California, approximately 3.5 million acres of federal lands fall under the NWFP as reserved land. This is approximately 6 percent of the 57 million acres of forested habitat within the Northern Spotted Owl’s California range. Reserved lands are intended to support groups of reproducing owl pairs across the species’ range. Unreserved land is defined as the federal land between reserved lands and is intended to provide recruitment of new owls into the territorial populations and is important for dispersal and movement of owls between larger reserves.

Table 11. Land-use allocations in the Northwest Forest Plan (adapted from Thomas et al. 2006)

Land-use allocation	Approximate Acres (%)
Congressionally reserved areas	7,323,783 (30)
Late-successional reserves	7,433,970 (30)
Managed late-successional reserves	102,242 (1)
Adaptive management areas	1,522,448 (6)
Administratively withdrawn areas	1,477,730 (6)
Riparian reserves	2,628,621 (11)
Matrix	3,976,996 (16)
<i>Total</i>	<i>24,465,790 (100)</i>

Comment [ABF85]: This would be more instructive if you included a column for just California

Reserved land includes late-successional reserves (LSRs), managed late-successional areas (managed LSAs), congressionally reserved lands, and larger blocks of administratively withdrawn lands. The LSRs cover about 30% of the NWFP area and were located to protect areas with concentrations of high-quality late-successional and old-growth forest on federal lands and to meet the habitat requirements of the Northern Spotted Owl (Thomas et al. 2006). Most LSRs were designed to accommodate at least 20 pairs of Northern Spotted Owls (FEMAT 1993). Timber harvesting is generally prohibited in LSRs.

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1793 However, silviculture treatments (including thinning in stands less than 80 years old west of the
1794 Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit
1795 the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging
1796 is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events
1797 such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that
1798 were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National
1799 Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district
1800 plans as being withdrawn from timber production and include recreational and visual areas, back
1801 country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily
1802 in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with
1803 smaller amounts of reserved lands on the coast (Figure 11).

1804 Unreserved land includes the matrix, adaptive management areas (AMAs), riparian reserves, small tracts
1805 of administratively withdrawn lands, and other small reserved areas such as 100-acre owl core areas.
1806 The matrix represents the federal land not included in any of the other allocations and is the area where
1807 most timber harvesting and other silviculture activities occur. However, the matrix does contain non-
1808 forested areas as well as forested areas that may be unsuited for timber production. Three of the major
1809 standards and guidelines for matrix land management are: (1) a renewable supply of large down logs
1810 must be in place; (2) at least 15% of the green trees on each regeneration harvest unit located on
1811 National Forest land must be retained; and (3) 100 acres of late-successional habitat around owl ACs
1812 must be protected (USDA and BLM 1994b). Timber harvesting is allowed within AMAs and like the
1813 matrix lands, AMAs are subject to the standards in the NWFP and in individual forest and district plans.
1814 Riparian reserves are a system of reserves defined by a set distance on each side of perennial and
1815 intermittent streams (Thomas et al. 2006) and may provide dispersal habitat for Northern Spotted Owls.

1816 Standards and guidelines for the management of both reserved and unreserved lands are described in
1817 the Record of Decision associated with the NWFP (USDA and BLM 1994b, Attachment A). A summary of
1818 management on each land use designation is provided below.

1819 Late Successional Reserves:

1820 Before habitat manipulation activities occur on LSRs, management assessments must be prepared.
1821 These assessments include a history and inventory of overall vegetative conditions, a list of identified
1822 late-successional associated species existing within the LSR, a history and description of current land
1823 uses within the reserve, a fire management plan, criteria for developing appropriate treatments,
1824 identification of specific areas that could be treated under those criteria, a proposed implementation
1825 schedule tiered to higher order plans, and proposed monitoring and evaluation components to help
1826 evaluate if future activities are carried out as intended and achieve desired results. The following
1827 standards must be followed for timber management activities in LSRs:

- 1828 • West of the Cascades – No timber harvest is allowed in stands over 80 years old. Thinning (pre-
1829 commercial and commercial) may occur in stands up to 80 years old in order to encourage
1830 development of old-growth characteristics.

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- East of the Cascades and in California Klamath Province – Silviculture activities should be designed to reduce catastrophic insect, disease, and fire threats. Treatments should be designed to provide fuel breaks but should not generally result in degeneration of currently suitable owl habitat or other late-successional conditions. Risk reduction activities should focus on young stands but activities in older stands may be undertaken if levels of fire risk are particularly high.
- Salvage in disturbed sites of less than 10 acres is not appropriate. Salvage should occur only in stands where disturbance has reduced canopy closure to less than 40%. All standing living trees should be retained, including those injured (e.g., scorched) but likely to survive. Snags that are likely to persist until late-successional conditions have developed should be retained. Appropriate levels of coarse woody debris should be retained. Some salvage will be allowed when it is essential to reduce fire risk or insect damage to late-successional forest conditions.

Managed Late Successional Areas:

Innovative silviculture techniques may be applied in managed LSRs. Proposed management activities are subject to review by the Regional Ecosystem Office, although some activities may be exempt from review. Within managed LSRs, certain silviculture treatments and fire hazard reduction treatments are allowed to help prevent complete stand destruction from large catastrophic events such as high intensity, high severity fires; or disease or insect epidemics. Managed LSAs should have management assessments as described for LSRs. Standards and guidelines for multiple-use activities other than silviculture are the same as for LSRs.

Congressionally Reserved Lands:

These lands are managed according to existing laws and guidelines established when the lands were set aside, and are generally managed to preserve natural resources (e.g., The National Park Service Organic Act of 1916, the National Parks Omnibus Management Act of 1998).

Administratively Withdrawn Areas:

There are no specific timber/silviculture standards and guidelines associated with administratively withdrawn areas. These areas have been identified as withdrawn from timber production in forest or district plans.

Riparian Reserves:

Riparian Reserves are managed to meet objectives of the Aquatic Conservation Strategy to help protect fish habitat and restore water quality. Timber harvest is prohibited within riparian reserves, including fuelwood cutting and salvaging (although some exceptions are made). Fuel treatment and fire suppression strategies and practices implemented within these areas are designed to minimize disturbance.

Matrix Lands:

Matrix lands are open to timber harvest subject to the standards in the NWFP and in the individual forest and district plans. The objective for Matrix lands is to “provide coarse woody debris well distributed across the landscape in a manner which meets the needs of species and provides for ecological functions” (USDA and BLM 1994b). Standards for Matrix lands in the NWFP include:

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- Coarse woody debris that is already on the ground is retained and protected from disturbance to the greatest extent possible during logging and other land management activities that might destroy the integrity of the substrate.
- Retention of at least 15% of the area associated with each cutting unit (stand).
- In general, 70% of the total area to be retained should be aggregates of moderate to larger size (0.5 to 2.5 acres or more) with the remainder as dispersed structures (individual trees, and possibly including smaller clumps less than 0.5 acres). Patches and dispersed retention should include the largest, oldest live trees, decadent or leaning trees, and hard snags occurring in the unit. Patches should be retained indefinitely (i.e., through multiple rotations to provide support for organisms that require very old forests).
- 100 acres of the best Northern Spotted Owl habitat must be retained as close to the nest site or owl activity center as possible for all known activity centers located on federal lands in the matrix and AMAs. These areas are managed in compliance with LSR management guidelines and are to be maintained even if Northern Spotted Owls no longer occupy them.

Adaptive Management Areas:

AMAs were intended to be focal areas for implementing innovative methods of ecological conservation and restoration, while meeting economic and social goals. Although there have been some successes in experimentation, most AMAs have been managed similarly to Matrix lands (Thomas et al. 2006). The NWFP established 10 AMAs, two of which are in California: Goosenest in northeastern California and Hayfork, which is located mostly in the Klamath province. One of the primary goals of the Goosenest AMA is to investigate means of accelerating the development of late-successional forest properties in pine forests. Mechanical treatments (forest thinning) and prescribed fire have been used experimentally to evaluate effect on development of late-successional forest properties in pine forests (Ritchie 2005). The emphasis for Hayfork is to investigate effects of forest management practices on the landscape, including partial cutting, prescribed burning, and low-impact approaches to forest harvest.

Standards and guidelines for LSRs and Congressionally Reserved Areas are followed where they fall within AMAs.

Section 7 Consultations

Section 7 of the Endangered Species Act requires all federal agencies to consult with the USFWS to ensure that any timber management action authorized, funded, or carried out by federal agencies is not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat (16 U.S.C. § 1536 subd. (a); 50 C.F.R. § 402). Section 7 requires the permitting instrument (i.e., biological opinion or letter of concurrence) to include measures to minimize the level of take to Northern Spotted Owl. Examples of take minimization measures may include:

- Restricted use of heavy equipment during the breeding season
- Retention of larger trees owl nesting/roosting and foraging habitat

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- 1908 • Retention of large snags and down logs within thinning units
- 1909 • Retention of hardwoods
- 1910 • Limited thinning within Riparian Reserves
- 1911 • Monitoring and surveys for Northern Spotted Owl throughout projects
- 1912

1913 *Forest Stewardship Contracting*

1914 The Agricultural Act of 2014 (“Agricultural Act of 2014, Section 8205, Stewardship End Result
1915 Contracting Projects”) grants the USFS and BLM authority to enter into stewardship contracting with
1916 private persons or public entities to perform services to “achieve land management goals for the
1917 national forests or public lands that meet local and rural community needs” (USFS 2009). Agreements
1918 allow contractors to remove forest products (goods) in exchange for performing restoration projects
1919 (services), the cost of which is offset by the value of the goods. Agreements may extend for up to 10
1920 years.

1921 Since the new authority became law, the USFS has awarded more than 30 stewardship projects. It is
1922 unknown how many USFS stewardship projects are in California. There are some inconsistencies in
1923 information regarding the number of BLM stewardship projects. The BLM Stewardship Contracting Fact
1924 Sheet
1925 ([http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.da](http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf)
1926 [t/stcontrBLM_Fact0115.pdf](http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf)) lists two stewardship projects that do not occur in California. However, the
1927 BLM website (http://www.blm.gov/wo/st/en/prog/more/forests_and_woodland/0.html) lists three
1928 forest stewardships in California: Weaverville Community Forest, South Knob, and Hobo Camp.

1929 *Bureau of Land Management*

1930 The standards and guidelines from the NWFP apply except where existing resource management plans
1931 are more restrictive or provide greater benefits to late-successional forest related species.

1932 Headwaters Forest Reserve

1933 Headwaters Forest Reserve is located in the north coast region of California and was purchased by the
1934 Secretary of Interior and the State of California in 1999 to preserve a large stand of old-growth redwood
1935 forest. The Headwaters Forest Reserve Resource Management Plan (USDOI et al. 2003; USDOI and BLM
1936 2004a) was developed with the goal to restore and maintain ecological integrity and to study ecological
1937 processes within the Reserve to improve management. Recreation and other management activities are
1938 constrained as necessary to be consistent with that primary goal. Old-growth forest habitat within the
1939 Reserve is managed to leave those systems undisturbed as core areas of optimal habitat. Second-growth
1940 forests are managed using tree thinning for restoration of old-growth characteristics. Priority is given to
1941 revegetating watershed restoration sites in old-growth areas and to treating harvested stands with old-
1942 growth remnants. Harvested stands that comprise early-mature and older seral stages (i.e., stands with
1943 an average stem diameter over 12 inches) are generally not thinned. Density-management treatments

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1944 do not yield commercial forest products; all biomass is left on-site and may be lopped and scattered,
1945 piled and burned, or chipped. Chain saws, mechanical brush cutters, and chippers may be used.
1946 Permanent or temporary roads or skid trails are not developed for access for treatment sites, but
1947 temporary access routes may be developed where they will be subsequently removed during watershed
1948 restoration activities.

1949 The desired outcome for Northern Spotted Owl is protection of existing habitat and expansion of
1950 suitable habitat for nesting, roosting, foraging, and dispersal habitat at the Reserve. The Resource
1951 Management Plan allows for the restoration of up to 2,757 acres of previously harvested stands. No
1952 suitable habitat for Northern Spotted Owl is to be removed or degraded during watershed restoration,
1953 forest restoration, or trail development. To the extent practicable, activities will be buffered from
1954 Northern Spotted Owl nesting habitat during the period of February 1 through July 31 by the use of
1955 vegetative screening or topographic screening and establishment of seasonal operating periods or a
1956 distance buffer of up to 0.25 mile. Off trail hiking is prohibited year-round.

1957 Fuels in second-growth forests are managed through tree thinning with materials lopped and scattered,
1958 piled and burned, or chipped; broadcast burning is not employed within the Reserve. Fuels are not
1959 managed in old-growth forests and generally not in second-growth forest once they achieve early-
1960 mature seral stage. Fire suppression uses a minimum-impact strategy. In second-growth forests dozers
1961 may be used; resource damage will be minimized and full rehabilitation of dozer fire lines will be
1962 required after fire suppression. In old-growth forests road access will be limited to existing road
1963 systems; hand crews or helicopter bucket drops may be deployed to attempt to contain fire.

1964 King Range National Conservation Area

1965 The King Range National Conservation Area (NCA) is located along the northern California coast about
1966 sixty miles south of Eureka and 200 miles north of San Francisco. The King Range NCA Management Plan
1967 (USDOI and BLM 2004b; USDOI and BLM 2005) applies to 68,000 acres of forested land. All of the
1968 forested lands in the planning area have been designated as a LSR under the NWFP, and therefore must
1969 be managed to promote late-successional forest characteristics. All active forest management activities
1970 in the Management Plan are focused only in the Front Country Zone, 25,661 acre zone representing a
1971 broad mix of uses and tools for management. Forest management activities in this zone are intended to
1972 develop more natural stand characteristics in areas that were previously harvested, improve watershed
1973 and fisheries health, and protection from wildfire risk. Some of these previously-logged areas have
1974 burned in high intensity fires, or are at risk for future fires of stand-replacing intensity. The primary goal
1975 in silvicultural treatments is to increase the Douglas-fir component in tanoak dominated stands, and
1976 “fireproof” this Douglas-fir component so that it has a greater chance to reach maturity.

1977 The Management Plan calls for the protection of sufficient Northern Spotted Owl habitat to attract and
1978 support 20 breeding pairs within the King Range NCA, as well as monitoring of known owl sites and
1979 periodic surveys in suitable habitat. At the time of the Management Plan development (2004), there
1980 were 12-14 known Spotted Owl activity centers in the King Range NCA. No timber harvests takes place in
1981 those activity centers.

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1982 *National Park Service*

1983 Redwood National and State Parks

1984 Redwood National Park was established in 1968 and was expanded in 1978. Three California state parks
1985 established in the 1920s—Prairie Creek Redwoods State Park, Del Norte Coast Redwoods State Park, and
1986 Jedediah Smith Redwoods—were included within the 1968 congressionally designated national park
1987 boundary. Since 1994, the four park units have been managed jointly as Redwood National and State
1988 Parks (RNSP) to the greatest extent possible, although the state parks are administered by the California
1989 Department of Parks and Recreation and the national park is administered by the NPS. Collectively,
1990 RNSP covers approximately 131,983 acres of land in northwest California reaching from the shoreline of
1991 the Pacific Ocean to the mountains of the Coast Range.

1992 In 2000, a joint federal-state management plan was developed to provide a clearly defined, coordinated
1993 direction for resource preservation and visitor use and a basic foundation for managing these four parks
1994 (NPS 2000a, NPS 2000b). There are nine management zones within the RNSP, each with different types
1995 and levels of use, management, and facilities that are allowed. Three zones cover most of the combined
1996 park area – the two backcountry zones (42.1% mechanized and 13.3% nonmechanized), and the
1997 primitive zone (32.6%). The backcountry zones and primitive zone have the most restricted access, and
1998 resource modification and degradation from visitor use in these zones is low. The remaining 12% of the
1999 park area is made up of six relatively small zones which are managed for various resources and for
2000 visitor operational needs.

2001 The RNSP General Management Plan (NPS 2000b) includes programs for watershed restoration,
2002 vegetation management, cultural resource management, interpretation and education, and facility
2003 development. Under the watershed restoration program, abandoned logging roads that contribute
2004 unnatural amounts of sediments into streams or threaten redwoods along park streams will be removed
2005 or treated to reduce erosion. The vegetation management program includes use of silvicultural
2006 techniques in second-growth forests to accelerate the return of characteristics found in old-growth
2007 forests and management of fire to support resource management strategies, including restoration of
2008 fire in old-growth forests.

2009 Prior to timber removal, the NPS will evaluate trees that are potential suitable nesting habitat for
2010 Northern Spotted Owl. The NPS take measures to reduce noise disturbance and loss of suitable habitat
2011 within one mile of occupied and unsurveyed potential suitable nesting habitat by operating outside the
2012 breeding season, using quiet equipment, or by implementing daily limited operating periods for heavy
2013 equipment during the breeding season. Protective buffer zones are used around known owl nest sites
2014 where visitor use activities are likely to result in disturbance.

2015 In 1978, Congress expanded RNSP to include 38,000 acres that had been logged between 1950 and 1978
2016 using clearcut tractor logging. With the expansion of the RNSP, commercial operations including active
2017 forest management and silviculture thinning ceased which resulted in second-growth forest conditions
2018 “considered unhealthy from both a silviculture and an ecological standpoint” (NPS 2008, NPS 2009a).

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2019 Many of the second-growth forest stands were primarily high-density, even-aged Douglas-fir stands with
2020 little canopy structure and no understory development. The focus of second-growth forest restoration is
2021 to reduce stand density (thinning) to promote growth of remaining trees while protecting adjacent old-
2022 growth forests, as well as maintaining water quality in riparian habitats, minimizing tanoak tree
2023 disturbance, and minimizing excessive fuel build-up on the forest floor.

2024 In 2009, the NPS planned to apply thinning prescriptions throughout 1,710 acres in the South Fork of
2025 Lost Man Creek, with the prescription dependent upon slope steepness, available road access, presence
2026 of streams and wetlands, tanoak density, and proximity to old growth forest.

2027 The USFWS issued a Biological Opinion (file number 8-14-2004-2133 81331-2008-F-00027, dated
2028 December 19, 2007) that concurred with the NPS determination that the project may affect but is not
2029 likely to adversely affect the Northern Spotted Owl. The project was expected to alter approximately
2030 1,539 acres of suitable Northern Spotted Owl habitat. However, the habitat was considered poor quality
2031 and the short-term adverse effects on owls from habitat alteration to be negligible. The project was
2032 expected to have long-term benefits for Northern Spotted Owl due to retention and protection of
2033 deformed trees and snags, and habitat improvement through acceleration of development of late-
2034 successional forest structure.

2035 In 2011, Redwood National Park completed a project to thin about 1,700 acres of second growth forest
2036 in the South Fork of Lost Man Creek (near the community of Orick) to accelerate the restoration of old-
2037 growth characteristics and functions.

2038 The RNSP General Management Plan called for preparation of a comprehensive trail and backcountry
2039 management plan to guide the development of an expanded trail system and prescribe policies and
2040 regulations for the use of backcountry areas by hikers, bicyclists, and equestrians. The Trail and
2041 Backcountry Management Plan (NPS 2009b) details the construction of seven hiking trails totaling 14.6
2042 miles, establishment of two bike trails totaling 10.3 miles, and construction of two new backcountry
2043 camps. Avoidance and minimization measures during construction include above ambient noise
2044 producing work conducted outside of the marbled murrelet noise restriction period (March 24-
2045 September 15) and Northern Spotted Owl presence surveys prior to construction (NPS and CDPR 2013).

2046 Fire management in RNSP includes suppression of wildfires, prescribed fire, mechanical fuel reduction,
2047 fire ecology research and fire effects monitoring, and fire operations planning (NPS 2010a, NPS 2010b).
2048 Fire suppression preparations include installing water tanks, preparing access roads, and removing
2049 hazardous fuels. Management actions are designed to avoid or minimize adverse effects on listed,
2050 proposed, or candidate threatened or endangered species and minimizes the effects on sensitive
2051 species. The NPS has developed guidelines to reduce or eliminate potential adverse effects on sensitive
2052 species from fire suppression in RNSP.

2053 Point Reyes National Seashore and Muir Woods National Monument

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2054 The Point Reyes National Seashore (PRNS) was established in 1962 and is located along the coast just
2055 north of San Francisco. The General Management Plan and Environmental Impact Statement for PRNS
2056 are currently under development.

2057 Due to a better understanding of the role of fire in ecosystem preservation and reducing fire risk, in
2058 2004 the NPS proposed to revise PRNS's Fire Management Plan to expand the use of prescribed fire and
2059 mechanical treatment for all lands under its management NPS 2004). In 2006, the Operational Strategy
2060 for the Fire Management Plan was published (NPS 2006a). The planning area for the Fire Management
2061 Plan includes the 70,046-acre PRNS as well as 18,000 acres of the Northern District of Golden Gate
2062 National Recreation Area. The Fire Management Plan allows up to 3,500 acres per year to be treated
2063 using prescribed fire and mechanical treatments. Measures in Northern Spotted Owl habitat include:

- 2064 • Annually identify and map areas where Spotted Owls are nesting.
- 2065 • Protect occupied and previously used nest sites from unplanned ignitions.
- 2066 • Do not conduct prescribed burns within 400 meters of an occupied or previously used nest
2067 site.
- 2068 • Do not conduct mechanical treatments with mechanized equipment within 400 meters of an
2069 occupied or previously used nest site between February 1 and July 31 (breeding season).
- 2070 • Conduct post-treatment monitoring to ascertain any impacts.
- 2071

2072 Muir Woods National Monument is managed by the NPS as part of the Golden Gate National Recreation
2073 Area. The General Management Plan Environmental Impact Statement for the Golden Gate National
2074 Recreation Area and Muir Woods was completed in 2014 (NPS 2014). The Record of Decision was
2075 expected to be completed in spring 2014 but has not been completed to date.

2076 The Fire Management Plan for Muir Woods allows up to 595 acres to be treated per year using
2077 mechanical treatments and prescribed fire (NPS 2006b). Measures to protect Northern Spotted Owl
2078 include:

- 2079 • Treatment activities or any noise generation above ambient noise levels will not occur within
2080 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential
2081 Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as
2082 surveys conforming to accepted protocol have determined that the site is unoccupied or non-
2083 nesting or nest failure is confirmed.
- 2084 • Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially
2085 alter the percent cover of canopy overstory and will preserve multilayered structure. When
2086 shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy
2087 will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency
2088 vehicle clearance.
- 2089 • Prior to fire management activities, project areas will be surveyed for the presence of dusky
2090 footed woodrat nests. If feasible, woodrat nests will be protected.

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- 2091 • Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a
- 2092 determination is made that the native tree presents a clear hazard in the event of a fire or
- 2093 cutting is the only option to reduce high fuel loading.
- 2094 • The fire management officer will arrange for qualified biologists to conduct post-project
- 2095 monitoring to determine short- and long-term effects of fire management actions on activity
- 2096 centers if resources are available.
- 2097

2098 Tribal Lands

2099 Hoopa Valley Indian Reservation

2100 The Hoopa Valley Indian Reservation is the largest reservation in California encompassing 90,767 acres,
2101 and located in the northeastern corner of Humboldt County. The Hoopa Valley Tribe has recently
2102 adopted a revised Forest Management Plan (FMP) covering the period of 2011-2026 (Higley 2012). The
2103 annual allowable timber harvest has been determined to be 8.889 million board feet (MBF) net per year
2104 of conifer volume and 3.1 MBF net of hardwood volume to be harvested within the Reservation.
2105 Northern Spotted Owl habitat losses are expected from implementation of the FMP due to timber
2106 harvest, urban development, road construction, and prairie restoration. About 8,980 acres of roosting-
2107 foraging and nesting-roosting-foraging habitat are estimated to be lost to timber harvest over the period
2108 covered by the FMP. These acres will be temporarily rendered unsuitable to Northern Spotted Owl,
2109 although the FMP notes that habitat will “recover eventually to at least foraging dispersal but likely to
2110 roosting-foraging habitat...within 30-40 years because of the retention of large structures within all
2111 units” (Higley 2012). Implementation of the FMP and associated projects will result in a decline in total
2112 suitable habitat by approximately 4.4% by the end of the planning period in 2026. Dispersal habitat will
2113 be reduced by approximately 4.9% at the end of 2021 but is expected to rebound to a net reduction of
2114 0.9% by 2026.

2115 The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late
2116 successional reserves to the north, south, and east, and Redwood National Park to the northwest. The
2117 reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40
2118 pairs of owls at all times during the planning period. However, the plan notes this number of Northern
2119 Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009
2120 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl
2121 detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning
2122 in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

2123 Eight forested management units noted in the FMP will retain Northern Spotted Owl dispersal habitat.
2124 None of the forested management units will dip below 50% cover of dispersal or higher quality habitat.
2125 The lowest level of owl habitat retention will occur within the Hopkins management unit, which at 72%
2126 at the time of the publication of the FMP, was projected to drop to 64% in 2012 and increase to 81% by
2127 2026.

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2128 The FMP includes management actions to mitigate affects to Northern Spotted Owl including land
2129 allocation restrictions, requirements for structural retention within timber sale units and hardwood
2130 management guidelines, and are inclusive of:

- 2131 • The no cut land allocation includes 24,581 acres of which 21,104 acres were forested as of 2011
2132 with stem exclusion or larger size class strata including 10,134 acres of old growth.
- 2133 • 2,819 acres are allocated as reserved for threatened and endangered species. 73 acres are
2134 specifically reserved to protect Northern Spotted Owl nesting core areas.
- 2135 • Seasonal restrictions will apply to all disturbance activities resulting from logging, site
2136 preparation, stand improvement, burning, road construction or reconstruction, and watershed
2137 restoration projects, etc. within 0.25 miles of any known Northern Spotted Owl pair at least until
2138 nesting status is determined from February 1 until July 31. Activities, which modify suitable
2139 nesting/roosting habitat, such as logging, will be further restricted until September 15 of each
2140 year or until the young owls are determined to be capable of moving away from the area or the
2141 reproductive attempt has been determined to have failed. For territories that have been
2142 surveyed continually and found to be unoccupied for 2 or more years, no restrictions shall be
2143 imposed.

2144 *Yurok Indian Reservation*

2145 The Yurok Indian Reservation is located in Del Norte and Humboldt counties inclusive of one-mile on
2146 each side of the Klamath River along a 44-mile stretch. There are approximately 59,000 acres in the
2147 entire Yurok Indian Reservation, and of these, approximately 3,320 acres are forested Tribal trust lands
2148 (i.e., land that the federal government holds legal title to but the beneficial interest remains with the
2149 Tribe), and 2,171 acres are forested allotted lands held in trust (Erler 2012). The remaining lands are fee
2150 lands (i.e., land acquired by the Tribe under legal title outside the boundaries of the Reservation, and in
2151 this case is primarily owned by Green Diamond Resource Company), which are managed intensively for
2152 timber products. Total forested Tribal ownership is 36,637 acres.

2153 The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all
2154 Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for intensive
2155 surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then
2156 dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites.
2157 The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest
2158 reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity
2159 centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl
2160 habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on
2161 disturbance activities within 0.25 mile of Northern Spotted Owl nest.

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2162 *Round Valley Indian Reservation*

2163 The Round Valley Indian Reservation encompasses about 23,200 acres in Mendocino County. More than
2164 two thirds of this area is off-reservation trust land. A total of 2,837 acres are allocated as “Available”
2165 under the Round Valley Indian Reserve FMP (Baldwin, Blomstrom, Wilkinson and Associates 2006),
2166 which means that programmed timber harvest may be allowed. As of 2006, there were eight known
2167 pairs of Northern Spotted Owl either nesting, roosting, or foraging on the Reservation. Approximately
2168 80% of the Reservation could be considered as suitable owl habitat, according to the FMP’s
2169 Environmental Assessment (2006). The FMP would impact about 13% of the 22,150 acres of suitable
2170 habitat on the Reservation. Uneven-aged forest management including single-tree and group selection
2171 is the preferred method, with a 20 year cutting cycle and 100 year rotation, although limited even-aged
2172 management is allowed in specific cases. Harvest is expected to be about 3.4 MFB/acre.

2173 **Nonfederal Land**

2174 *History of Timber Management on Nonfederal Lands and the Forest Practice Rules*

2175 The California Department of Forestry and Fire Protection (CAL FIRE; <http://www.calfire.ca.gov/>)
2176 enforces the laws that regulate logging on privately-owned lands in California. These laws are found in
2177 the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will
2178 also preserve and protect California’s fish, wildlife, forests, and streams. Additional rules enacted by the
2179 State Board of Forestry and Fire Protection (BOF) are found in state regulations and are collectively
2180 referred to as the Forest Practice Rules. The purpose of the Forest Practice Rules is to implement the
2181 provisions of the Forest Practice Act in a manner consistent with other laws, including the California
2182 Environmental Quality Act (CEQA) of 1970, the Timberland Productivity Act of 1982, the Porter Cologne
2183 Water Quality Act, and the California Endangered Species Act (CESA).

2184 CAL FIRE ensures that private landowners abide by these laws when harvesting trees. Although there are
2185 specific exemptions in some cases, compliance with the Forest Practice Act and the Forest Practice Rules
2186 apply to all commercial harvesting operations for private landowners from ownerships composed of
2187 small parcels to large timber companies with thousands of acres.

2188 A Timber Harvesting Plan (THP) is generally the environmental review document submitted by
2189 landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the
2190 steps that will be taken to prevent damage to the environment. THPs are prepared by Registered
2191 Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process
2192 substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber
2193 harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

2194 In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by
2195 the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These
2196 biologists would become the first “designated biologists” who would consult on proposed THPs.

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2197 Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules
2198 and procedures that would be adopted in the event of listing. The rules identified descriptions of
2199 Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for
2200 timber operations to avoid take. The rules called for consultations between plan proponents and
2201 Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to
2202 amend the initially adopted emergency rules; amendments to the rules occurred several times as
2203 knowledge of the Northern Spotted Owl increased and with experience gained through implementation
2204 of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and
2205 919.10 [939.10] in March 1991, which describe options and procedures that can be used in THPs to
2206 avoid take of Northern Spotted Owl or to proceed under incidental take authorization.

2207 Section 919.9 [939.9] includes subsections (a) through (g), which are procedures (referred to as
2208 “options”) among which THP submitters must select and then must follow for THPs within the range of
2209 the Northern Spotted Owl or the “Northern Spotted Owl Evaluation Area” as defined in the Forest
2210 Practice Rules, and for THPs that are situated outside of this Evaluation Area that are within 1.3 miles of
2211 known owl activity centers. The option that is selected must meet on-the-ground circumstances. The
2212 information that each option requires is to be used by CAL FIRE to evaluate whether or not the proposed
2213 timber operations under the THP would result in unauthorized Northern Spotted Owl take. Subsections
2214 (a), (b), (c) and (f) involve CAL FIRE consulting with a Spotted Owl Expert (SOE). An SOE is defined in the
2215 Forest Practice Rules as a person with requisite documented education and experience whose
2216 qualifications have been referred by CAL FIRE to USFWS or the Department for evaluation.

2217 Subsection (a) provides the project proponent the option before a THP is filed of requesting an SOE to
2218 complete a preliminary review of the proposed timber operations to evaluate whether Northern
2219 Spotted Owl take would occur. The SOE must apply the criteria for Northern Spotted Owl take avoidance
2220 specified in Section 919.10 [939.10], and must inform the project proponent whether the proposed
2221 timber operations would or would not cause take. In practice, if an SOE concludes take would be
2222 avoided, the results of such a preliminary review would be included in a THP when submitted to CAL
2223 FIRE for filing, review and approval.

2224 Subsection (b) includes a list of information the project proponent must disclose in a THP; including
2225 functional Northern Spotted Owl habitat within and outside the THP area both before and after harvest,
2226 known owl detections, information on owl surveys conducted and results and other information. It
2227 requires a discussion of how functional Northern Spotted Owl habitat will be protected according to
2228 criteria presented in Section 919.10.

2229 Subsection (c) provides the project proponent the option of obtaining from an RPF a certification to be
2230 included in the THP that Northern Spotted Owls are inferred absent from the THP area and out 1.3 miles
2231 from the THP area based on the results of surveys completed according to the USFWS survey protocol,
2232 (USFWS 2012) and the RPF’s personal knowledge and a review of information in the Northern Spotted
2233 Owl database maintained by the Department.

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2234 Subsection (d) involves the project proponent proceeding under the provisions of an incidental take
2235 permit issued by USFWS or the Department.

2236 Subsection (e) allows the project proponent to proceed with timber harvest according to the outcome of
2237 a consultation with USFWS. This outcome is memorialized in what is referred to as a “technical
2238 assistance letter” from USFWS.

2239 Subsection (f) allows the project proponent to disclose in the THP the outcome of an SOE’s preliminary
2240 review as described under Subsection (a), to demonstrate that any measures to avoid Northern Spotted
2241 Owl take recommended by the SOE have been adopted in the THP and that the proposed timber
2242 operations evaluated by the SOE remain substantially the same in the submitted THP.

2243 Subsection (g) is an option appropriate for THPs where one or more Northern Spotted Owl activity
2244 center has been located within the THP area or within 1.3 miles of its boundary. This option requires the
2245 RPF to determine and document activity center-specific protection measures to be applied under the
2246 THP and that various specified forms and acreages of functional owl habitat (nesting, roosting and
2247 foraging) will be retained post-harvest around each activity center. The minimum acreages to be
2248 retained after harvest of functional nesting, roosting and/or foraging habitat within 500 feet, 500 to
2249 1,000 feet, 0.7 mile and 1.3 miles around each activity center are specified in this subsection.

2250 Section 919.10 [939.10] of the Forest Practice Rules presents the criteria CAL FIRE is to apply to
2251 information provided in the THP and during the THP review period to make a finding as to whether or
2252 not the proposed timber operations will avoid Northern Spotted Owl take in the form of “harass, harm,
2253 pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct”, as
2254 defined under Endangered Species Act (ESA). If CAL FIRE concludes take would occur, they must provide
2255 reasons why the determination was made according to criteria presented in section 919.10 [939.10] ,
2256 what information was used in making the determination, and recommend minimum changes to the
2257 proposed THP to avoid take. According to Forest Practice Rules Section 898.2, Special Conditions
2258 Requiring Disapproval of Plans, CAL FIRE shall disapprove a THP if the THP would cause Northern
2259 Spotted Owl take prohibited by the ESA.

2260 Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were
2261 provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following
2262 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could
2263 inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol,
2264 breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly
2265 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans
2266 and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol
2267 was revised (USFWS 2012).

2268 When consultations with the USFWS were required, they consisted of a field review of the proposed
2269 THP area, an evaluation of the pre-harvest and predicted post-harvest habitat typing (its suitability for
2270 nesting, roosting, or foraging), the sufficiency of habitat retained post-harvest within 500 feet, 0.7 mile
2271 and 1.3 mile of owl ACs, and an evaluation of the adequacy of the surveys that were conducted (i.e.

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2272 timing, location, interpretation of results) and their consistency with the USFWS protocol. When
2273 appropriate, the Department designated biologists would evaluate or propose THP-specific habitat and
2274 temporal buffers that differed from standard Forest Practice Rules habitat retention and seasonal
2275 restriction requirements that would be adopted as enforceable conditions of THPs.

2276 In 1991, a curriculum was designed to train private consulting biologists who could conduct the field and
2277 document review portions of a Northern Spotted Owl consultation, although final approval from a
2278 Department designated biologist was still required. University biologists and biological consultants,
2279 along with designated Department Timber Harvest Assessment Program staff helped THP submitters to
2280 evaluate their plans with regard to potential take of Northern Spotted Owls. Workshops helped calibrate
2281 consultants, RPFs and others regarding owl life history, habitat associations, and so forth. Northern
2282 Spotted Owl consultations for most THPs were conducted by the Department designated biologists from
2283 1991 into 1997.

2284 From 1991 through 1997 the Department and to a much lesser extent, CAL FIRE staff processed
2285 Northern Spotted Owl consultations for THPs. Additionally, Department staff participated in the review
2286 of private timber company Habitat Conservation Plans, Spotted Owl Management Plans, and Spotted
2287 Owl Resource Plans. In 1994, Department staff was directed to give Northern Spotted Owl consultations
2288 its highest priority and to set aside a minimum number of days per week to address a consultation
2289 backlog. In this same year, CAL FIRE staff was directed to suspend processing of consultations.

2290 In 1995 the Department established a process for certifying “Private Consulting Biologists” (PCBs) to
2291 fully conduct Northern Spotted Owl consultations, which included approval of a consultation package,
2292 and discontinuing the need for additional approval from a Department designated biologist. However,
2293 Department staff continued to process consultations not prepared or reviewed by PCBs.

2294 Beginning in 1999, Department staff no longer processed THP Northern Spotted Owl consultations and
2295 no longer reviewed the work of private consultant biologists. Reasons for the suspension of processing
2296 included:

- 2297 • Other emerging and compelling forestry sector conservation issues required Department staff’s
2298 attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related
2299 workload).
- 2300 • The Department “Timber Harvest Assessment Program” (later to become the “Timberland
2301 Conservation Planning Program”) budget did not include funding specifically for consultations.
- 2302 • Staffing of USFWS offices with wildlife biologists had increased.
- 2303 • The Department felt CAL FIRE and USFWS staff were capable of review, approval, and
2304 assessment of THPs and NTMPs.
- 2305 • The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- 2306 • The scope, quality and conformance of owl-related information with Forest Practice Rules
2307 requirements appeared to have stabilized after approximately six years of implementation.

2308

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2309 Regardless of the suspension in consultation involvement, the Department continued to evaluate THPs
2310 with regard to potential significant impacts to Northern Spotted Owl from timber operations, and as
2311 appropriate reminded THP proponents to comply with Section 3503.5 of the Fish and Game Code. In
2312 addition, the Department continued monitoring compliance with Northern Spotted Owl-related Habitat
2313 Conservation Plan's conservation measures.

2314 At the time that the Department suspended processing of THP and Nonindustrial Timber Management
2315 Plans (NTMP) consultations (1999), the USFWS technical assistance program began. After nine years of
2316 processing technical assistance requests from applicants, the USFWS notified CAL FIRE in 2008 that
2317 technical assistance requests would have to come directly from CAL FIRE rather than the applicant.
2318 Detailed written guidance and information associated with the analysis process was provided to CAL
2319 FIRE, along with scheduled workshops, to assist in the transition from the USFWS to CAL FIRE (USFWS
2320 2008b). The guidance somewhat deviates from the Forest Practice Rules and included information
2321 needed for Northern Spotted Owl technical assistance, descriptions and appropriate uses for the 1- and
2322 2-year owl survey protocols, owl take avoidance scenarios, and the take avoidance analysis process,
2323 habitat retention criteria within 0.5, 0.7 and 1.3 mile radius from the activity center, and a description of
2324 habitat parameters (i.e., nesting/roosting/foraging habitat) for both the interior and coastal regions.
2325 Since this time, CAL FIRE has been responsible for reviewing the majority of Spotted Owl-affected THPs,
2326 and has assisted applicants and USFWS by assessing technical assistance requests if forwarded to
2327 USFWS.

2328 In 2009, the USFWS developed a white paper, Regulatory and Scientific Basis for the U.S. Fish and
2329 Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in
2330 California's Northern Interior Region, to scientifically justify why the 2008 guidance deviated from the
2331 Forest Practice Rules (USFWS 2009). Specific criteria within the USFWS guidelines, and how they differ
2332 from the Forest Practice Rules, are discussed in the Timber Harvest section below.

2333 The Department Timber Harvest Assessment Program was eliminated in late 2010. From a high of 33
2334 staff members state-wide in 2007, fewer than eight remained engaged in forestry environmental review
2335 and permitting in 2011. The remaining positions were assigned to other programs in the Department,
2336 and in some cases were still involved in a range of forestry-sector work (e.g., lake or streambed
2337 alteration agreements, natural community conservation plans, sustained yield plans and limited THP
2338 environmental review).

2339 In 2013, a new Department "Timberland Conservation Planning Program" (TCP) was established through
2340 a stable funding source and authorities mandated pursuant to Assembly Bill 1492 (2012), to ultimately
2341 increase staff to 41 in Department Headquarters and in four Department Regions. Today, TCP Staff
2342 members participate in THP review, process lake or streambed alteration agreements, complete species
2343 consultations (including "pre-consultations") for "sensitive species" and those that are listed or
2344 candidates for listing pursuant to CESA, review forest habitat restoration grant proposal, and other
2345 activities. In addition, as required by Assembly Bill 1492, TCP staff are mandated to and will soon embark
2346 on inspections of approved and completed THPs and compliance and effectiveness monitoring.
2347 Department staff members selectively review Northern Spotted Owl-related information disclosed in

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THPs as part of routine THP environmental review; however, with the broad suite of other mandated THP review-related responsibilities, the TCP's allocated staffing and resources are not adequate to allow staff to engage in Northern Spotted Owl consultations at the level and in ways they did in the 1990s.

Timber Harvest Management

Timber Harvest Plans

As noted previously, a THP is a document that outlines the level and type of proposed timber harvest, and details steps to be taken to prevent damage to the environment, including measures to avoid take of Northern Spotted Owl. Landowners prepare THPs following the provisions of the Forest Practice Rules, and select options for which to follow (Section 919.9 [939.9], subsections (a) through (g)). The purpose of these options is to avoid take of Northern Spotted Owl.

After reviewing all THPs within the Northern Spotted Owl range submitted to CAL FIRE in 2013, it was apparent that Forest Practice Rules section 919.9[939.9], subsections e and g (hereafter referred to as Option (e) and (g)), were the most frequently used among THPs submitted, and thus, have the greatest potential to impact owl habitat. Other THPs applied Section 919.9/939.9, subsections a, b, and d. Therefore, for THPs submitted in 2013 utilizing Option (e) and (g), we assessed each THP, available through CAL FIRE, for consistency and appropriate application regarding impact avoidance to the Northern Spotted Owl.

For the THPs assessed, proposed silvicultural prescription method and acreage was summarized by county. Silvicultural prescription methods are defined in the Forest Practice Rules, and are included in Appendix 1. In addition, for each THP utilizing Option (e) and (g), the potential impact of proposed harvest to activity centers in each option was assessed as well. Due to the different habitat retention guidance for interior and coastal THPs, the assessment conducted for interior counties were conducted only for THPs associated with activity centers within 1.3 miles of the proposed project, and the assessment for coastal counties included only THPs that were associated with activity centers within 0.7 miles.

Within the range of the Northern Spotted Owl in California, a total of 175 THPs were submitted to CAL FIRE in 2013 from ten counties (Del Norte, Humboldt, Mendocino, Shasta, Siskiyou, Sonoma, Napa, Marin, Tehama, and Trinity counties). Of these, 115 THPs were associated with owl activity centers, encompassing approximately 69,226 acres of proposed harvest on private timberland. Figures 12 and 13 summarize number and percent of THPs submitted from each county on the interior and coastal regions. Of the 115 THPs, 93 were coastal THPs associated with owl activity centers within 0.7 mile, and 22 were interior THPs associated with owl activity centers within 1.3 miles.

Of the 115 THPs associated with owl activity centers, a total of 66 utilized Option (e) (60 coastal and six interior), and 9 utilized Option (g) (two coastal and seven interior) in 2013. Silvicultural prescription methods and associated acres of proposed harvest from the 66 THPs that applied Option (e) in 2013 are summarized in Figure 14. Silvicultural prescription methods and associated acres of proposed harvest

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from the nine THPs that applied Option (g) in 2013 are summarized in Figure 15. Variable Retention prescription was the most utilized method for THPs using Option (e), with nearly 28,000 acres of proposed harvest. Alternative, Clear Cut, and Shelterwood prescriptions were the most utilized method for THPs using Option (g), with 1,413, 714, and 657 acres of proposed harvest, respectively. The number of THPs and the cumulative proposed acres for THPs utilizing Option (e) far surpassed those using Option (g).

Proposed silvicultural prescription methods and harvest amounts within the interior and coastal THPs varied significantly. The dominant methods and acreages for 2013 interior and coastal THPs that used Option (e) and Option (g) and are associated with activity centers are summarized in Table 12. In the interior, the Alternative method was proposed more than any other method, covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total acreage. When the Alternative method is used, the plan must include a description of which silvicultural method is most nearly appropriate or feasible, and must also describe how the Alternative method differs from the most similar method. For plans using the Alternative method in the interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the Alternative method used. Alternative method units typically include a habitat retention area, which can range from 2-10% of the harvest unit. Habitat retention areas usually include hardwoods and/or cavity trees to promote use by wildlife species. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more area than all other methods combined.

Table 12. Silvicultural prescription methods proposed within 1.3 miles of an activity center in interior THPs and within 0.7 miles of an activity center in coastal THPs in 2013.

<u>13 THPs from</u>		<u>62 THPs from</u>	
<u>Interior Counties</u>	<u>Acre</u>	<u>Coastal Counties</u>	<u>Acre</u>
Alternative	9,798	Variable Retention	28,144
Group Selection	2,389	Selection	5,227
Clear Cut	2,257	Group Selection	4,314
Shelterwood Removal	1,574	Transition	3,470
Commercial Thinning	1,335	Seed Tree Removal	1,645
No Harvest Areas	1,015	Clear Cut	1,404
		Rehabilitation	990

To better understand the level of impact of proposed harvest and retention to owl activity centers, each THP utilizing Option (e) and Option (g) in 2013 within the interior and coastal region was assessed further. For 13 interior THPs (six using Option (e) and seven using Option (g)), habitat retention and harvest were assessed at two scales: within 0.5 miles and between 0.5 and 1.3 miles of an activity center. For 62 coastal THPs (60 using Option (e) and two using Option (g)), habitat retention and harvest was only assessed within 0.7 miles of an activity center.

It is important to note that the Forest Practice Rules and USFWS guidance regarding habitat retention vary. As mentioned previously, the Forest Practice Rules outline appropriate retention guidelines to be established within THPs submitted under Option (g). In 2009, the USFWS made recommendations for

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2417 habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat
2418 from Forest Practice Rules guidelines.

2419 Forest Practice Rules guidelines under Option (g) are:

- 2420 • Nesting habitat must be retained within 500 feet of the activity center
- 2421 • Roosting habitat must be retained within 500-1000 feet of the activity center
- 2422 • 500 acres of owl habitat must be provided within 0.7 mile radius of the activity center
- 2423 • 1336 acres of owl habitat must be provided within 1.3 mile radius of the activity center

2424 The USFWS (2009) recommendations are:

- 2425 • No timber removal within 1000 feet of activity center, either inside of outside of the breeding
2426 season
- 2427 • At least 250 acres of nesting/roosting habitat and at least 150 acres of foraging habitat must be
2428 retained within 0.5 mile radius of the activity center
- 2429 • Between 0.5-1.3 mile radius of the activity center at least 655 acres of foraging habitat and 280
2430 acres of low quality foraging habitat must be retained

2431 As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern
2432 Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option
2433 (e) in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2434 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center
2435 once timber harvesting had been completed. For each of the six interior THPs, four primary habitat
2436 types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting
2437 as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option
2438 (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a
2439 given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-
2440 habitat.

2441 Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for
2442 THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior,
2443 and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the
2444 interior (2,117 acres within 0.5 miles and 9,776 acres within 0.5-1.3 miles). On the coast, foraging and
2445 nesting/roosting were retained at relatively similar levels within 0.7 miles (52,817 acres of foraging;
2446 47,344 acres of nesting and roosting).

2447 As noted previously, seven interior THPs and two coastal THPs associated with a total of 14 Northern
2448 Spotted Owl activity centers (8 interior activity centers, and 6 coastal activity centers) utilized Option (g)
2449 in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2450 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center
2451 once timber harvesting had been completed. For each of the seven interior THPs, habitat types were
2452 assessed: low quality foraging, foraging, and nesting and roosting. For the two coastal THPs that utilized
2453 Option (g) a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given

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2454 THP. For these two THPs, three primary habitat types were assessed: foraging, nesting/roosting, and
2455 non-habitat.

2456

2457 **Table 13.** Proposed acres of habitat retention near activity centers from THPs utilizing Option (e) in 2013. Totals
2458 include retention acres for 6 interior THPs and 60 coastal THPs (66 THPs total). Owl habitat is defined as low quality
2459 foraging (LQF), foraging (F), nesting/roosting (NR), high quality nesting/roosting (HQNR), and non-habitat (NH).

	<u>6 Interior THPs associated with 14 activity centers, Option (e)</u>		<u>60 Coastal THPs associated with 132 activity centers, Option (e)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	770	4,702	n/a
F	2,117	9,776	52,817
NR	1,487	6,324	47,344
HQNR	1,649	2,940	n/a
NH	n/a	n/a	31,222

2460

2461 Table 14 summarizes proposed acres of owl habitat retention within the interior and coastal regions for
2462 THPs utilizing Option (g). Total acreages presented are cumulative acres for 7 THPs within the interior,
2463 and 2 THPs within the coast. Within the interior, nesting/roosting and foraging habitat were similarly
2464 proposed for retention, with Low Quality Foraging the least common habitat type retained. Within the
2465 coast, nesting/roosting habitats were retained more than either foraging or non-habitat.

2466

2467 **Table 14.** Proposed acres of habitat retention near activity centers from THPs utilizing Option (g) in 2013. Totals
2468 include retention acres for 7 interior THPs and 2 coastal THPs (9 THPs total). Owl habitat is defined as low quality
2469 foraging (LQF), foraging (F), nesting/roosting (NR), and non-habitat (NH).

	<u>7 Interior THPs associated with 8 activity centers, Option (g)</u>		<u>2 Coastal THPs associated with 6 activity centers, Option (g)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	612	3,004	n/a
F	1,032	3,171	1,548
NR	1,388	3,879	2,763
NH	n/a	n/a	1,597

2470

2471 Over time, activity centers may be cumulatively impacted by timber management activities. Through the
2472 use of Option (e) and Option (g), habitat retention and harvest for interior THPs from 2013 were
2473 typically assessed within 0.5 miles and between 0.5 and 1.3 miles of an activity center; whereas for
2474 coastal THPs from 2013 habitat retention and harvest were assessed primarily within 0.7 miles of an
2475 activity center. The 0.5 mile and 0.7 mile radius around activity centers is meant to capture the core
2476 habitat use of Spotted Owls within their home range, whereas the 1.3 mile radius is meant to capture

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2477 the broader home range. Therefore timber harvest within these radii has a potential to impact quality
2478 and extent of owl habitat, and consequently, owl fitness. As discussed previously, to mediate this loss
2479 the Forest Practice Rules set limits on the amount and type of habitat that may be harvested within
2480 certain radii. Since timber growth is slow, and consequently, regrowth of owl habitat is slow, it is
2481 important to understand the cumulative impact to activity centers over time.

2482 To consider the risk of habitat removal to individual activity centers, the amount of habitat proposed for
2483 harvest was calculated for activity centers addressed in THPs utilizing Option (e) and Option (g) over
2484 various periods in time between 1986 and 2013 (Tables 15 and 16). The activity centers evaluated were
2485 selected from those that were associated with THPs submitted in 2013; these activity centers were
2486 evaluated over time by evaluating all THPs associated with these activity centers in past harvest history.
2487 The sample selected for evaluation did not include all of the activity centers associated with THPs in
2488 2013, only a subset. Activity centers were chosen from all counties associated to provide results on a
2489 broad scale. An approximately even number of activity centers were chosen from each county. At the
2490 proposed levels of harvest noted in the THPs, it is apparent that some activity centers have experienced
2491 extensive habitat removal or modification over time. Of the 17 activity centers evaluated in the interior,
2492 six activity centers have experienced greater than 2,000 acres timber harvest cumulatively over time
2493 within the 1.3 mile radius (~3,400 acres) home range, and six activity centers have experienced greater
2494 than 250 acres timber harvest within the 0.5 mile radius (~500 acres) core range. Of the 14 activity
2495 centers evaluated on the coast, six activity centers experienced harvest of over 500 acres, cumulatively,
2496 within the 0.7 mile radius (~985 acres) core range, with two of these over 1,000 acres. Appendix 3
2497 includes bar graphs for each activity center within the coast and interior, and depicts level of harvest
2498 within 0.5, 0.7, and 1.3 mile radii from the activity center.

2499 It is reasonable to assume that high levels of harvest, such as shown for some activity centers in Table 15
2500 and 16, can negatively impact Northern Spotted Owls. Although no study has been conducted
2501 specifically linking the amount of harvest within the 0.5, 0.7, and 1.3 mile radius of an activity center to
2502 impacts on owl fitness (e.g., reproductive rate, survival, etc.), several research studies have
2503 demonstrated a link between owl fitness and amount of habitat, structural characteristics, and spatial
2504 configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007). These studies
2505 are discussed in more depth above in the Habitat Requirements section (Habitat Effects on Survival and
2506 Reproduction) and below in the Habitat Loss and Degradation threat section of this document. Through
2507 comparison of Northern Spotted Owl territory loss on private and federal lands, the USFWS (2009)
2508 suggests that the Forest Practice Rules have not been entirely effective in preventing cumulative loss of
2509 important owl habitat surrounding activity centers associated with repeated harvest. Details regarding
2510 the USFWS analysis can be found in the Regulatory Mechanisms Consideration section of this document.

2511

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2512 **Table 15.** Proposed timber harvest (in acres) within interior THPs utilizing Option (e) and Option (g) over time
2513 (range 1997-2013), showing level of harvest within 0.5 miles and between 0.5-1.3 miles of activity centers. The
2514 activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were
2515 evaluated over time by evaluating all THPs associated with these activity centers since 1997.

Activity Center	Range of Harvest Years	Interior, Option (e) Acres harvested		Interior, Option (g) Acres harvested	
		0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)	0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)
SIS0492	2004-2013	0	915	x	x
SIS0554	1998-2004	102	589	x	x
TEH0030	1998-2013	381	2,554	x	x
TEH0037	1998-2013	379	2,221	x	x
TEH0038	1998-2013	151	1,002	x	x
TEH0072	1998-2013	476	1,954	x	x
TEH0075	1997-2004	277	2,530	x	x
TEH0087	1998-2013	291	2,137	x	x
TEH0101	1997-2013	168	2,113	x	x
TEH0114	2002	0	8	x	x
TEH0117	2006-2013	37	1,123	x	x
SHA0024	2003-2005	x	x	41	239
SHA0037	1998-2013	x	x	0	426
SHA0106	2000-2013	x	x	21	160
SIS0319	1997-2013	x	x	31	1,505
TRI0169	2000-2013	x	x	0	118
TRI0316	1997-2013	x	x	251	495

2516
2517

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Table 16. Proposed timber harvest (in acres) within coastal THPs utilizing Option (e) and Option (g) over time (range 1986-2013), showing level of harvest within 0.7 miles of activity centers. The activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by evaluating all THPs associated with these activity centers since 1986.

Activity Center	Range of Harvest Years	Coast, Option (e) Acres harvested within 0.7 mile radius (~985 acre core area)	Coast, Option (g) Acres harvested within 0.7 mile radius (~985 acre core area)
HUM0058	2011-2013	30	x
HUM0400	1990-2013	510	x
HUM0622	1993-2013	798	x
HUM0791	1999-2013	270	x
HUM0986	1997-2013	162	x
MEN0146	1994-2013	1,180	x
MEN0309	1987-2013	565	x
MEN0370	1992-2010	413	x
HUM0097	1996-2013	x	345
HUM0098	2004-2005	x	67
HUM0308	1996-2013	x	226
HUM0442	2004-2013	x	227
MEN0082	1986-2013	x	1,316
MEN0114	1987-2013	x	829

Nonindustrial Timber Management Plans

In 1989, the Legislature added language to the Forest Practice Act creating provisions to include Nonindustrial Timber Management Plans (NTMPs) to promote long term management and planning on forest ownerships of 2,500 acres or less (Pub. Resources Code §4593 et seq.). Private forestlands are generally classified into non-industrial and industrial ownerships based on acreage and association with industrial uses. Non-industrial private forest (NIPF) owners typically have less than 5,000 acres of forestland and do not own a mill. Of the private forestlands in California, NIPF owners collectively hold about 3.2 million acres (41%), with the balance being held by industrial forest landowners.

The NTMP allows smaller NIPF timberland owners to prepare a long-term management plan that reduces regulatory time and expense by providing an alternative to submitting individual THPs prior to harvest. Landowners agree to manage their forests through uneven-aged management and long-term sustained yield, in exchange for a higher degree of regulatory surety. “Sustained yield” means the yield of commercial wood that an area of commercial timberland can produce continuously at a given intensity of management consistent with required environmental protection and which is professionally planned to achieve over time a balance between growth and removal (Pub. Resources Code, § 4593.2, subd. (d); Forest Practice Rules, § 895.1). Timberland owners operating under an NTMP are also protected under provisions of Public Resources Code section §4593, which offers landowners exemption

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2541 from applying subsequent rule changes to Forest Practice Rules to their project; however, this does not
2542 mean that a NTMP will never be subject to new laws or regulations.

2543 Public Resources Code section §4594 subdivision (h) requires RPFs to submit a Notice of Operations
2544 (NTO) prior to harvest that specifies that the NTMP will implement best management practices for the
2545 protection of water, soil stability, forest productivity, and wildlife, as required by the current rules of the
2546 Board, or is consistent with the original plan and will not result in any significant degradation to the
2547 beneficial uses of water, soil stability, forest productivity or wildlife. Required applications and
2548 administration of NTMPs are detailed in the Forest Practice Rules commencing with section 1090.
2549 Landowners submitting proposed NTO's subsequent to requirements of Forest Practice Rules, section
2550 919.9 [939.9] subdivisions (a) through (g), are expected to either contain specific measures that fulfill
2551 these requirements or best management practices equivalent to such provisions. These options have
2552 resulted in variable and diverse Northern Spotted Owl protection measures within NTMPs; however,
2553 Options (e) and (g) are the most commonly used options. As stated previously, Option (e) allows
2554 landowners to submit a technical assistance letter to the USFWS for approval. Under Option (g), the
2555 landowner must supply the location of activity centers located within the plan boundary or within 1.3
2556 miles of the boundary.

2557 NTMP prevalence has grown steadily since its inception. Table 17 summarizes the approaches
2558 landowners took to protect comply with Forest Practice Rules in avoiding take of Northern Spotted Owl
2559 through NTMPs over time, including numbers of NTMPs within 1.3 miles of an activity center and the
2560 those NTMPs utilizing Option (e) and Option (g) over 1991-2014 for the interior forests, and 2005-2014
2561 for the coastal forests. A total of 157 NTMPs were evaluated within the range of the Northern Spotted
2562 Owl: 35 from the interior portion of the range that were submitted from 1991-2014, and 122 from the
2563 coastal portion of the range that were submitted from 2005-2014. It should be noted that the majority
2564 of NTMPs on the coast were submitted prior to 2005 (418 NTMPs in 1991-2004 versus 122 NTMPs in
2565 2005-2014). However time did not allow full review of that time period for coastal NTMPs. Of the 157
2566 NTMPs evaluated, 115 are within 1.3 miles an owl activity center. Option (e) and Option (g) were applied
2567 in 114 and 14 NTMPs, respectively.

2568 During 1991 through 2014 35 NTMPs have been approved for landowners in the interior portion of the
2569 Northern Spotted Owl range (Siskiyou, Trinity, Shasta, and Tehama counties), with 10 plans utilizing
2570 Option (e), 10 plans utilizing Option (g) and the remainder using another option. Of the 35 NTMPs, 19
2571 (54%) were associated with at least one Northern Spotted Owl activity center within 1.3 miles of the
2572 plan boundary. The coastal portion of the range (Humboldt, Mendocino, Sonoma, Lake, and Napa
2573 counties) saw substantially more NTMPs within a shorter time frame. From 2005 to 2014, 122 NTMPs
2574 were submitted and approved. Although Del Norte County is part of the owl's range, no NTMPs were
2575 submitted during this time frame. Of the 122 NTMPs evaluated, 96 (78%) were associated with at least
2576 one activity center within 1.3 miles of the plan boundary. Of these, the majority (104 NTMPs) utilized
2577 Option (e) (i.e., USFWS technical assistance letter); therefore, the USFWS has been instrumental in
2578 providing consultation and guidance to NTMPs submitters as it relates to protection measures for
2579 Northern Spotted Owl and their habitat.

Comment [A86]: Note to external reviewers:
We are currently working to get all coastal NTMPs (1991-2014) summarized in the table. This will be included in the next version. In addition, number of ACs associated with the NTMPs will be added for all counties.

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2580 **Table 17.** Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years
2581 2005-2014 for plans in Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	NTMPs in NSO Range	NTMPs within 1.3 miles of NSO	NTMPs that implemented 939.9 (e)	NTMPs that implemented 939.9 (g)	NTMPs that used other options
<i>Interior Counties 1991-2014</i>					
Siskiyou	16	13	6	7	1
Trinity	6	3	2	2	0
Shasta	11	3	2	1	0
Tehama	2	0	0	0	2
Interior Subtotal	35	19	10	10	3
<i>Coastal Counties 2005-2014</i>					
Humboldt	41	40	38	2	0
Mendocino	58	45	43	2	0
Sonoma	19	9	19	0	0
Lake	3	1	3	0	0
Napa	1	1	1	0	0
Coastal Subtotal	122	96	104	4	0
Total	157	115	114	14	3

2582

2583

2584 For NTMPs in Siskiyou, Trinity, and Shasta counties measures were analyzed for proposed silvicultural
2585 prescription methods for years 1991-2014, and for years 2005-2014 in Humboldt, Mendocino, Sonoma,
2586 Lake, and Napa counties (Table 18). Only NTMPs that occurred within 1.3 miles of a Northern Spotted
2587 Owl activity center were included in this analysis; therefore, Tehama NTMPs have been excluded.
2588 Silvicultural prescription methods noted in Table 18 are those most often proposed within the NTMPs
2589 analyzed. Other prescriptions proposed but not included in Table 18 include Road Right of Way,
2590 Sanitation Salvage, Special Treatment, Fuel break, and Variable Retention, and is inclusive of 747
2591 cumulative acres.

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Table 18. Acres proposed for harvest under NTMPs within 1.3 miles of a Northern Spotted Owl activity center for various silvicultural prescriptions. NTMPs are from years 1991-2014 for Siskiyou, Trinity, and Shasta counties, and 2005-2014 for Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	Selection	Group Selection	Uneven-aged	Commercial Thinning	Non-Timberland Area	Transition	Rehabilitation of under-stocked
<i>Interior Counties 1991-2014</i>							
Siskiyou	2597	60	1127	251	22	251	251
Trinity	2783	237	653	0	0	0	0
Shasta	1609	1036	2276	273	463	0	0
Interior Subtotal	6989	1333	4056	524	485	251	251
<i>Coastal Counties 2005-2014</i>							
Humboldt	2322	6139	0	35	424	1101	1658
Mendocino	4561	1926	0	0	419	975	71
Sonoma	547	4603	0	0	127	245	246
Lake	45	587	0	0	0	0	0
Napa	0	683	0	0	17	0	0
Napa-Lake	1858	0	0	0	0	0	0
Coastal Subtotal	9333	13938	0	35	987	2321	1975
Total	16322	15271	4056	559	1472	2572	2226

2595

2596 Of the NTMPs included in this analysis, a total of 42,478 acres were proposed for harvest within 1.3
 2597 miles of an activity center. Selection, Group Selection, and Uneven-aged silvicultural methods are the
 2598 most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through
 2599 the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection,
 2600 Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Most plans that
 2601 used the Uneven-aged silvicultural method did not delineate acres that would fall under each category.
 2602 For NTMPs submitted on the interior from 1991-2014, Selection, Group Selection, and Uneven-aged
 2603 totaled 6,989, 1,333, and 4,056 acres, respectively. For NTMP submitted from 2005-2014 on the coast,
 2604 Selection and Group Selection totaled 9,333 and 13,938 acres, respectively. Cumulatively, these more
 2605 common silvicultural methods equates to 29% (12379/42478) of the total acres proposed for harvest

Comment [ABF87]: What % was this of the total acreage within all 1.3 mile areas around activity centers? That is, what is the context here?

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2606 under interior NTMPs analyzed, and 55% (23271/42478) of the total acres proposed for harvest under
2607 coastal NTMPs analyzed.

2608 The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl
2609 habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear
2610 that some information was not available to the reviewer due to the nature of the older NTMP
2611 narratives, limited public information, and subsequent amendment submissions. There is simply no
2612 effective way to track this information in an analysis going back in time. Though Selection and Group
2613 Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range,
2614 we can infer that owl habitat is retained to some extent; however, we could not determine the type or
2615 quality of habitat retained. For instance, high quality nesting and roosting habitat may be harvested
2616 more frequently, thereby reducing owl fitness.

2617 Spotted Owl Management Plans

2618
2619 A Spotted Owl Management Plan (SOMP) details measures to avoid take of Northern Spotted Owl as a
2620 result of timber harvest operations on privately owned land. SOMP are developed cooperatively
2621 between USFWS and a private land owner, and can be used to streamline the review of THPs. SOMP
2622 follow the procedures in Forest Practice Rules section 939.9 subdivision (e) and include:

- 2623 • a description of the area covered
2624 • protection measures for breeding or nesting Northern Spotted Owls
2625 • habitat definitions, and
2626 • habitat quality and quantity retention requirements

2627
2628 SOMP are contain expiration dates upon which USFWS and land owners meet to review and revise the
2629 document as necessary; however, incorporation of new scientific information may occur at any time
2630 during the lifetime of the SOMP. SOMP differ from the standard no-take measures provided in the
2631 Forest Practice Rules in that they utilize site-specific information in conjunction with research to develop
2632 strategies to avoid take over a period of years. The most notable difference between SOMP no-take
2633 requirements and those in the standard Forest Practice Rules section is the primarily survey area
2634 required and possibly habitat required post-harvest. Survey areas may be reduced as a result of local
2635 information collected over a number of years. Post-harvest habitat requirements may also be greatly
2636 reduced or increased based on site specific local information.

2637 Three SOMP are currently being used in the THP process in California. Two of these were reviewed for
2638 this assessment by the Department, totaling 175,700 acres in Siskiyou, Trinity and Shasta Counties. The
2639 Department never received a copy of the third SOMP, located in Mendocino County; therefore we are
2640 unable to discuss it here. Both documents reviewed included the elements listed above, and were
2641 developed with the USFWS considering site-specific information for those properties. Within the SOMP
2642 reviewed, suitable habitat definitions were developed specifically for the ownership(s) utilizing the
2643 SOMP. These habitat definitions are developed using information from the property and may be
2644 different from those suitable habitat definitions in survey protocols or other rules or regulations.

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2645 It is not known if the long-term use of SOMP on private lands in California is limiting Northern Spotted
2646 Owl populations, but all operations conducted under a SOMP occur within the known range of Northern
2647 Spotted Owl and usually within suitable owl habitat. More information is needed to fully understand the
2648 effects of SOMP on Northern Spotted Owls.

2649 Spotted Owl Resource Plans

2650

2651 A Spotted Owl Resource Plan (SORP) is intended to offer landowners submitting THPs a programmatic
2652 approach to avoid take of Northern Spotted Owl. SORPs are addressed in Forest Practice Rules section
2653 919.9 subdivision (a), and is defined as, "...an approach to preventing a taking of the northern Spotted
2654 Owl while conducting timber operations [,]" and "...necessarily involves more than one timber harvest
2655 plan." SORPs do not differ significantly from the required habitat retention guidelines found in the
2656 Forest Practice Rules section 919.9 subdivision (g), and mainly provide a programmatic method for
2657 Northern Spotted Owl protection. A description of the area covered, protection measures for breeding
2658 or nesting Northern Spotted Owls, habitat definitions, survey areas and habitat quality and quantity
2659 retention requirements are all provided within a SORP. A SORP may be submitted to CAL FIRE for
2660 preliminary review, and once approved, can be attached to individual THPs submitted by a landowner
2661 under Forest Practice Rules section 919.9 subdivision (a). The THP is reviewed by the Department, but
2662 not necessarily the SORP.

2663 A total of three SORPs have been approved and are being utilized in the THP process in California, and a
2664 fourth SORP is being prepared. The three approved SORPs cover a total of 358,202 acres. All three
2665 SORPs use a combination of no-take language from Forest Practice Rules section 939.9, along with site-
2666 specific information to develop no-take requirements. No specific habitat definitions were developed for
2667 SORPs, and thus, either standard habitat definitions from the Forest Practice Rules or standard habitat
2668 definitions from the USFWS are used within the plans. The site-specific information is used mostly for
2669 protocol survey areas and noise disturbance buffer distances, and is usually developed from historical
2670 survey records and independent noise level studies.

2671 It is not known if the long-term use of SORPs on private lands in California is limiting Northern Spotted
2672 Owl populations, but all operations conducted under a SORP occur within the known range of Northern
2673 Spotted Owl usually are within suitable owl habitat. More information may be needed to fully
2674 understand the effects of SORPs on Northern Spotted Owls.

2675 Habitat Conservation Plans

2676

2677 Under Section 10(a) of the ESA incidental take, defined as take that is incidental to and not the purpose
2678 of the carrying out of an otherwise lawful activity, may be authorized for federally threatened and
2679 endangered species via a Habitat Conservation Plan (HCP). California's Natural Community Conservation
2680 Planning Act of 1991 takes a broader approach than either CESA or ESA. A Natural Community
2681 Conservation Plan (NCCP) identifies and provides for the protection of plants, animals, and their
2682 habitats, while allowing compatible and appropriate economic activity. HCPs and NCCPs are both long-
2683 term landscape level conservation plans that allow harvest of Northern Spotted Owl habitat, which
2684 could result in a specified level of incidental take of owls within the plan area. Generally, these plans

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2685 require historic and occupied Northern Spotted Owl activity centers to be monitored to ensure a healthy
2686 and stable population, suitable foraging, and nesting habitat to be maintained or created, and activities
2687 to be adjusted accordingly using an adaptive management approach.

2688 Five HCPs that include Northern Spotted Owl as a covered species have been issued in California (Table
2689 19). One plan, on Mendocino Redwood Company land, is in the development process and will be a
2690 combination HCP and NCCP. Each of these plans is described in more detail below.

2691 **Table 19.** Current and planned HCPs/NCCPs in California that include Northern Spotted Owl as a covered species.

Plan Title	Location	Date Permit Issued	Term
Green Diamond Resource Company California Timberlands & Northern Spotted Owl HCP	Humboldt, Del Norte, Trinity Counties	09/17/1992	30 years
Regali Estates HCP	Humboldt County	08/30/1995	20 years
Humboldt Redwood Company HCP	Humboldt County	03/01/1999	50 years
Terra Springs LLC HCP	Napa County	03/03/2004	30 years
Fruit Growers Supply Company HCP	Siskiyou, Shasta, and Trinity Counties	11/27/2012*	50 years
Mendocino Redwood Company HCP/NCCP	Mendocino County	No permits issued	80 years

*A recent court decision in April 2015 determined the Fruit Growers Supply Company HCP to be invalid.

2692
2693
2694 *Green Diamond Resource Company Northern Spotted Owl HCP*

2695
2696 Green Diamond Resource Company (GDRC) inherited the existing Northern Spotted Owl HCP when they
2697 acquired Simpson Timber Company (STC 1992). The HCP has a 30-year term, which expires September
2698 17, 2022, and calls for a full review at the end of 10 years of implementation. GDRC owns approximately
2699 383,100 acres of forestland in California within the Northern Spotted Owl range, mostly within Del Norte
2700 and Humboldt counties, with only small portions in Mendocino and Trinity counties, and is located
2701 within the California Coast Province. Of the 383,100 acres, 86% are conifer forests comprising two
2702 dominant species, coastal redwood, and Douglas-fir. Since most of the conifer forests have been
2703 harvested over the last several decades, second-growth makes up all but a small fraction. Residual areas
2704 of old-growth forests (logged in the early 1940s and 1960s) make up less than 3%, and are concentrated
2705 in the more inland portions of GDRC ownership. Forested areas never logged (virgin old-growth) are
2706 scattered throughout the land ownership and consist of 150 acres of redwood and 300 acres of Douglas-
2707 fir, comprising less than 2% of GDRC land. Hardwood forests (oak species, madrone, alder) comprise 8%,
2708 and non-forest (grassland, wetland, rock and river bars) 6%. As of 1991, just prior to issuance of the HCP,
2709 146 ACs were known to occur on GDRC lands. Density of owls was much higher in the southern portions
2710 of land ownership, than the northern portion (1.2 owls/mi² and 0.32 owls/mi², respectively).

2711 During development, the HCP prepared a 30-year age-class forecast model to determine how much
2712 habitat would be available to owls over time, and developed a predictive habitat (nesting mosaic) model
2713 to estimate nesting habitat on the GDRC land ownership. The age-class forecast covered 1991 through
2714 2021, and assumed timber harvest would occur at an annual rate of 3,000-6,000 acres. Results indicated

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2715 that second-growth stands in the 46+ year age-class would more than double, the 31-45 year age-class
2716 would increase by approximately 50,000 acres in first 10 years then return to 1991 levels, and the 8-30
2717 year age-class would generally decrease over time. The nesting mosaic model was designed to
2718 determine the mosaics of habitat types associated with owl activity centers and utilized the 1991 cover
2719 types and age-classes. Results initially indicated 158,477 acres of GDRC land fit the nesting mosaic
2720 profile, with the number of ACs in 2021 would be roughly the same as the 1991 level.

2721 The level of take (via owl displacement and habitat modification) was estimated at 3 pairs per year over
2722 first 10 years through direct habitat modification (habitat removal within owl sites), and 2 owls per year
2723 over first 10 years via indirect displacement (habitat removal in adjacent stands to owl sites).
2724 Conservation measures were developed to avoid or minimize the likelihood of take, and include:

- 2725 • Habitat management and nest site protection. Implementation will protect nest sites during
2726 breeding and fledging periods, maintain foraging, roosting and nesting habitat, and accelerate
2727 growth of replacement stands. Stands to be harvested March through August will be surveyed
2728 for Spotted Owls before entering area, as well as a 1,000 ft buffer around the area planned for
2729 harvest. Just prior to harvest, up to three more surveys will be conducted. Nest trees will be
2730 marked and no timber harvest is to be conducted within a 0.25 mile radius until after young
2731 have fledged or the nest fails, and a 500 ft radius after fledging until the young disperse.
2732 Valuable land resources for Spotted Owls will be retained on the landscape, such as
2733 hardwood/conifer patches, habitat along watercourses, snags, standing live culls, and brush.
- 2734 • Development of a research program. A research program consists of ongoing owl surveys,
2735 banding owls, monitoring reproductive success, identifying important nest site attributes, and
2736 assessing abundance and distribution.
- 2737 • Development of habitat area to be set-aside. Thirty-nine habitat set-asides were identified in
2738 which timber harvest would not occur. The total acreage of these set asides is 13,242.5 acres
2739 and, as of HCP issuance, 39 owl sites. A 0.25 mile or 500 foot buffers are placed around sites to
2740 ensure timber removal or other associated harvest activities adjacent to set-asides to not impact
2741 owl sites within. Set-asides were monitored annually.
- 2742 • Staff training. A program was developed to properly train GDRC employees and contractors to
2743 monitor owls and collect data.

2744
2745 The trigger for any course correction required during the HCP term will be if the reproductive rate falls
2746 below the rate of the Willow Creek Study Area (WCSA) for three consecutive years. The WCSA was a
2747 good comparison at the time due to its proximity to GDRC and its unique long-term Spotted Owl
2748 dataset. Since 1993, comparisons of reproductive rates at GDRC and WCSA show that the study area
2749 with higher annual reproductive rate often shifts between the two areas. There have not been three
2750 consecutive years with statistically significant results showing the reproductive rate at GDRC falling
2751 below that at WCSA (GDRC 2015).

2752 According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was
2753 happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the

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2754 understanding of suitable owl habitat was limited. In 2006, GDRC submitted an application to the
2755 USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was
2756 issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes
2757 the Project, requires the Applicant to comply with terms of the amended BO and its associated
2758 incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified
2759 the Department that the BO was issued and requested that the Department issue a consistency
2760 determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1.
2761 In January 2014, the Department found that BO, its related ITS and ITP, and the HCP were consistent
2762 with CESA and meet the conditions set forth in Fish and Game Code section 2081 for authorizing
2763 incidental take of CESA-listed species (CDFW 2014a).

2764 The Department found that the mitigation measures identified in the amended ITP and HCP will
2765 minimize and fully mitigate the impacts of take and the continued existence of Northern Spotted Owl
2766 will not be compromised. Measures in the amended versions include, but are not limited to:

- 2767 • Maintaining a 20,310 acres “Special Management Area” in Upper Mad River area where Spotted
2768 Owls may not be taken.
- 2769 • Survey for Spotted Owls in each area where timber harvest is planned, and delay harvest of nest
2770 site and primary activity centers in after the breeding season.
- 2771 • Maintain records of surveys and actual take and notify the USFWS events such as direct harm to
2772 owls, catastrophic events that destroy owl sites, shifts in distribution, accidental death, or injury
2773 of owls, and the finding of dead or injured owls.
- 2774 • Continue gathering data on owl behavior and habitat needs, and update GIS database regularly.
- 2775 • Establish 39 set-asides that represent 13, 252 acres in which timber harvest is not allowed.
- 2776 • Retain, where feasible, resources values that would provide future owl habitat.
- 2777 • Comply, where feasible, with “Overall Resource Management” measures specified in the HCP,
2778 including retention of canopy cover, ground cover, habitat along streams, and a variety of tree
2779 sizes and species within WLPZs.
- 2780 • Implement research on habitat overlap and interactions between Spotted Owls and Barred
2781 Owls.
- 2782 • Conduct surveys according to approved Spotted Owl protocol that accounts for occupancy and
2783 Barred Owl presence, and contact the USFWS for direction as appropriate.
- 2784 • Prepare annual report to record actual instances and number of Spotted Owl sites displaced,
2785 level of habitat loss within owl sites, actual and estimated levels of displacement of past year,
2786 estimated levels of displacement for future year, estimate number of owl sites and amount of
2787 owl habitat, pre- and post-harvest estimates of snags and residual trees in THP areas, results of
2788 nest and set-aside monitoring, and assess efficacy of measures to date.
- 2789 • Provide Department with letter to document financial assurances for HCP implementation.
- 2790

2791 The last annual report (GDRC 2015) described survey results for September 2013 through August 2014
2792 and met the reporting requirements noted above. Since 1992, there has been an overall increase in the

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total amount of Northern Spotted Owl habitat, indicating that growth of forest stands into owl habitat surpassed forested stands impacted by timber harvest. The primary form of incidental take anticipated in the HCP is the displacement of owls due to modification of owl habitat. It was recognized that such displacement could impair essential behavioral patterns and result in actual death or injury to owls. Rather than examining the circumstances of each case to determine whether a take as defined in the ESA had in fact resulted from Green Diamond's habitat modification, the implementation agreement calls for reporting as a "displacement" any instance where an owl site itself is harvested or habitat around an owl site is reduced below thresholds established in the HCP. Each displacement is originally reported on the basis of harvest activity in relation to an owl site within a particular home range; however owls that were recorded as displaced can be removed from the cumulative total if minimum occupancy and nesting criteria are met in the years post-harvest. Based on displacement removal criteria, 33 owls that were recorded as displacements (based on harvest activity) have been removed from the cumulative total (i.e., they are not considered displaced under terms of the HCP). Green Diamond's incidental take permit allows 58 owl pairs to be taken during the 30 year term of the HCP. Although the number of reported displacements per year has been variable, the average is approximately three owl sites per year, leading to 47 owls displaced since 1993 (GDRC 2015).

Regali Estates HCP

This HCP covers 480 acres in Humboldt County, southeast of the town of Ferndale, and is located within the California Coast Province (Regali Estate 1995). Its 20-year term expires August 30, 2015. The plan covered two Northern Spotted Owl activity centers, and contains white-fir, Sitka spruce, redwood, young tree plantations, grassland, and agriculture. The harvest of conifer species resulted in the immediate loss of nesting habitat for one pair. Due to its small size, take afforded by the plan was not deemed to impact regional Spotted Owl populations. Measures set for the plan included: (1) Retention of habitat around nest sites; (2) No harvest impact for a portion of the covered area; (3) Retention of foraging habitat in harvested areas; (4) Salvage of only commercially valuable dead and dying trees; (5) Planting of conifer trees in open grassland habitat; (6) Retention of slash piles for prey habitat; (7) Monitoring of owls; and (8) Completion of biannual reports.

Humboldt Redwood Company HCP

The HRC HCP covers 211,700 acres of coast redwood and Douglas-fir forest in Humboldt County, and is located within the California Coast Province (HRC 2014). Currently the Plan Area contains approximately 208 Northern Spotted Owl activity centers. The term is 50 years, which means the plan will expire March 1, 2049. The primary covered activity is timber management (timber harvest and regeneration, site preparation, planting, vegetation management, thinning, and fire suppression) occurring on approximately 203,000 acres. The HCP requires ongoing monitoring and reporting to ensure that the conservation measures being implemented are accomplishing the desired outcomes. Through the adaptive management process, the monitoring results were used to develop an updated HCP on March 31, 2014.

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- 2830 The overall strategy in the Northern Spotted Owl conservation plan, detailed in the HCP, is to (1)
2831 minimize disturbance to Northern Spotted Owl activity sites, (2) monitor to determine whether these
2832 efforts maintain a high-density and productive population of owls on the ownership, and (3) apply
2833 adaptive management techniques when new information on owl biology/ecology is available and to best
2834 assess the performance of management objectives. Specific habitat retention requirements are
2835 provided to conserve habitat for nesting, roosting, and foraging owls.
- 2836 Northern Spotted Owl management objective outlined in the plan include:
2837
2838 1. Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 2839 2. Maintain Northern Spotted Owl pairs on an average of 80 percent (over a five-year period) of
2840 the minimum 108 activity centers on the ownership. At least 80 of these sites shall be “Level
2841 One” sites, and the balance shall be “Level Two” sites.
- 2842 3. Maintain an average reproductive rate of at least 0.61 fledged young per pair (over a five-year
2843 period) for the minimum of 108 activity centers on the ownership.
- 2844 4. During the first five years of the HCP, maintain and document the minimum number of activity
2845 centers designated in the HCP.
- 2846 Northern Spotted Owl conservation measures outlined in the plan include:
2847
2848 1. Establish a Northern Spotted Owl Scientific Review Panel to review and make recommendations
2849 for monitoring techniques, offer expert review of monitoring results, and make
2850 recommendations on habitat retention standards for maintenance and recruitment of activity
2851 centers.
- 2852 2. Conduct a complete annual censuses (or and approved sampling methodology) to monitor all
2853 activity centers on the ownership and to determine numbers of pairs, nesting pairs, and
2854 reproductive rates.
- 2855 3. If activities are initiated before February 21 and are maintained continuously past the onset of
2856 the breeding season (March 1 through August 31) the THP and a 1,000 foot buffer is to be
2857 surveyed, with timing and number of surveys dependent on when activities are to occur within
2858 the breeding season. For site preparation activities initiated between March 1 and May 31 site
2859 visits will be conducted based on known activity centers within 1,000 feet of activity. Details on
2860 how and when site visits are to occur are site specific. No surveys required if timber operations
2861 occur only outside the breeding season.
- 2862 4. Before June 1 each year, at least 80 activity sites shall be maintained using the habitat retention
2863 guidelines detailed in the HCP, referred to as “Level One” habitat retention. Activity sites
2864 selected for “Level One” retention must have supported owls in the previous year and must also
2865 be active for the year in which the site is selected. If a site is determined to be nesting, no
2866 harvesting shall occur during the breeding season within a 1,000-foot radius of the nest tree.

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- 2867 Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the
2868 activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting
2869 habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable
2870 owl habitat must be provided, if present, and less than 50 percent of this shall be under
2871 operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided,
2872 within 1.3 miles of each activity center.
- 2873 5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of
2874 each year to make up the minimum number of activity centers designated by the HCP. “Level
2875 Two” habitat retention must be active for the year in which the site is selected. If a site is
2876 determined to be nesting, no harvesting shall occur during the breeding season within a 1,000-
2877 foot radius of the nest tree. Following the breeding season, 18 acres around the AC shall be
2878 maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC
2879 must be in place. For sites, which have been determined to be occupied by a non-nesting pair
2880 or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if
2881 present, and a 400 foot radius buffer protecting the activity center must be in place. Harvesting
2882 of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat
2883 retention area.
- 2884 6. Activity center that are not needed to meet management objectives above shall receive “Level
2885 Three” protection measures. These activity centers shall have a 1,000-foot buffer during the
2886 breeding season. Timber harvest associated may occur before March 1 or after August 31.
2887 During the breeding season, for activity centers which have been determined to be occupied by
2888 a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as
2889 suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur
2890 during the breeding season in the area adjoining the 18-acre habitat retention area.
- 2891 7. All nest trees shall be marked and be retained if the activity center is harvested.
- 2892 The HCP outlines an objective to conserve habitat diversity and structural components within the plan
2893 area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types
2894 and seral stages are maintained across the landscape over the permit period, as well as structural
2895 components, to contribute to the maintenance of wildlife species covered under the plan, including the
2896 Northern Spotted Owl.
- 2897 Structural components to be retained include:
- 2898 1. A certain number and size snags that do not pose a human safety hazard.
- 2899 2. A certain number and size of green replacement trees, if snags are not present, with a priority
2900 for trees other than redwood.

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- 2901 3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority
2902 given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or
2903 cavities.
- 2904 4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a
2905 maximum of two per acre.
- 2906 5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given
2907 to logs over 30 inches in diameter.
- 2908 In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that
2909 the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section
2910 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in
2911 fact consistent with CESA and meet the conditions set forth in Fish and Game Code section 2081 for
2912 authorizing incidental take of CESA-listed species (CDFW 2014b).
- 2913 The Department found that the mitigation measures identified in the amended ITP and HCP will
2914 minimize, will fully mitigate the impacts of take and will not compromise the continued existence of
2915 Northern Spotted Owl. Measures in the amended versions include, but are not limited to:
- 2916 • Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and
2917 federal governments to ensure their functions as wildlife reserves in perpetuity.
- 2918 • Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting
2919 habitat in a series of Marbled Murrelet Conservation Areas (MMCA's).
- 2920 • Conduct a combination of night and daytime surveys and stand searches to locate both known,
2921 and any new, owl activity centers.
- 2922 • Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other
2923 conservation elements of the HCP for the retention and recruitment of potential foraging,
2924 roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
- 2925 • Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 2926 • Maintain an average reproductive rate of at least 0.61 fledged young per pair, over a five-year
2927 period, for the minimum of 108 activity centers on the ownership.
- 2928 • Conduct complete annual censuses to monitor all activity centers on the ownership and to
2929 determine numbers of pairs, nesting pairs, and reproductive rates.
- 2930 • Survey the THP area and a 1,000-foot buffer for new operations, except site preparation,
2931 initiated in the period beginning February 21 and ending on or before August 31.
- 2932 • Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and
2933 detection probabilities using accumulated survey data.
- 2934 • Submit annual reports describing the activities undertaken, results of the Operating
2935 Conservation Program, and the proposed Operating Conservation Program activities for the next
2936 year for all lands covered by the HCP.
- 2937

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2938 Annual reports for Northern Spotted Owl have been developed since the HCP's inception. The most
2939 current report (HRC 2015) summarizes the Humboldt Redwood Company's survey effort and whether
2940 management objectives were met. The report states,

2941 "Management objective 1 of the HCP, which requires the maintenance of a minimum of 108
2942 activity sites in the HCP area, was met in 2014 with 136 total occupied activity sites including the
2943 108 core sites. There are currently 215 total activity sites (occupied and unoccupied) on the
2944 property. Management objective 2, which calls for maintenance of Spotted Owl pairs on a five
2945 year running average of 80% at core activity sites, was met in 2014 with a running average of
2946 82%. The pair occupancy rate for 2013 was also 84% (91 of the 108 cores sites were occupied by
2947 a pair of Spotted Owls). Management objective 3 requires the maintenance of a five-year
2948 running average reproductive rate of at least 0.61 fledged young per pair for the core sites (for
2949 those pairs monitored to determine reproductive output). Nesting activity was verified for 33 of
2950 the 91 pairs (of the 108 core sites), and a total of 45 young were fledged, resulting in a
2951 reproductive rate of 0.49 in 2014. The five-year running average of the reproductive rate for the
2952 fifteenth year of the HCP is 0.42, below the requirements of management objective 3."

2953 *Mendocino Redwood Company HCP/NCCP (in planning process; not issued)*

2954 The Mendocino Redwood Company (MRC) is in the process of developing a HCP and NCCP with the
2955 federal and state agencies. Once the permit is issued, the term will be 80 years. The HCP/NCCP will
2956 determine how MRC manages threatened and endangered species, rare plants, and natural
2957 communities on their land ownership in Mendocino and Sonoma counties. The Northern Spotted Owl
2958 will be a covered species in the plan. Approximately 228,800 acres of coast redwood and Douglas-fir
2959 forests exist on MRC land ownership and is located within the California Coast Province. Up to date
2960 progress on the HCP/NCCP development can be found on the MRC website (<http://www.mrc.com>).

2961 *Terra Springs LLC HCP*

2962
2963 The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the
2964 Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa
2965 County west of the city of St. Helena, and is located within the California Coast Province. The plan has a
2966 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year
2967 old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered
2968 lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the
2969 covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded
2970 by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to
2971 maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while
2972 accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting,
2973 roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their
2974 management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees,
2975 felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices,
2976 retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous

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2977 snags, retention of down logs; (3) Timber operations to cease within a 1000 ft buffer of the owl activity
2978 center during the breeding season; (4) Monitor the Spotted Owl site for five years subsequent to the
2979 timberland conversion; and (5) Annual reporting for the first 5 years of the permit.

2980 *Fruit Growers Supply Company HCP*

2981
2982 The Fruit Growers Supply Company (FGS) HCP covers commercial timberland owned and managed by
2983 FGS in Siskiyou County, totaling 152,178 acres (FGS 2012). The Plan Area is within the California Klamath
2984 Province and California Cascades Province. The HCP has a 50 year term that expires November 27, 2062.
2985 In February 2014, FGS notified the Department that the federal BO was issued and requested that the
2986 Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1.
2987 In March 2014, after an amendment to the HCP to fully meet mitigation standards, the Department
2988 found that BO and its related ITS and ITP, and the HCP were consistent with CESA and meet the
2989 conditions set forth in Fish and Game Code section 2081 for authorizing incidental take of CESA-listed
2990 species (CDFW 2014c).

2991 In April 2015, the United States District Court, Northern District of California, found FGS's HCP to be
2992 invalid for the incidental take of two threatened species, the Northern Spotted Owl and the Southern
2993 Oregon/Northern California Coast Coho Salmon. The Order on Cross-Motions for Summary Judgment in
2994 the case *Klamath-Siskiyou Wildlands Center, Center for Biological Diversity, and Klamath Forest Alliance*
2995 *vs. National Oceanic and Atmospheric Administration, National Marine Fisheries, and the United States*
2996 *Fish and Wildlife Service, and Fruit Growers Supply Company* states, "For the reasons explained below,
2997 the Court ... finds the incidental take permits issued by the Services, the biological opinion issued by
2998 NMFS, and the Final Environmental Impact Statement invalid." The HCP amendment to fully meet
2999 mitigation standards was not considered in this case.

3000 Timber management was the primary activity affecting approximately 150,000 acres. FGS land consists
3001 of three management units: Klamath River covering 65,340 acres, Scott Valley covering 39,153 acres,
3002 and Grass Lake covering 47,685 acres. Klamath River and Scott Valley units are dominated by second-
3003 growth mixed evergreen forests that include Douglas-fir, incense-cedar, white fir, ponderosa pine, sugar
3004 pine, canyon live oak, Pacific madrone, California black oak, and Oregon white oak. The Grass Lake unit
3005 contains three major forest types: Sierran Montane Forest and Upper Montane Forest at higher
3006 elevations and Northern Yellow Pine Forest at lower elevations. The Northern Yellow Pine is most
3007 common in the Grass Lake unit, and is dominated by ponderosa pine and white fir. The hardwood
3008 understory species (e.g., oak species and madrone) are largely absent in this unit. Because most of FGS
3009 land has been in commercial timber production since the early 1900s, forests are relatively young (less
3010 than 80 years old) with only small, isolated patches of older stands. Less than 1 percent of the forested
3011 area in the three management units are in WHR size class 5 (> 24 inches dbh) and are considered late-
3012 seral stage. Most of the forested lands (79-93%) are in WHR size classes 3 and 4 (6-24 inches dbh) and
3013 are considered mid-seral.

3014 Covered Activities had the potential to alter forest characteristics, and influence the availability and
3015 quality of habitat for Northern Spotted Owls. Northern Spotted Owl surveys on FGS lands and adjoining

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3016 federal and private lands have shown that many activity centers are located on or have a home range
3017 that extends onto the FGS ownership.

3018 Safe Harbor Agreements

3019
3020 The USFWS states (<http://www.fws.gov/endangered/landowners/safe-harbor-agreements.html>):

3021 “A Safe Harbor Agreement (SHA) is a voluntary agreement involving private or other non-
3022 Federal property owners whose actions contribute to the recovery of species listed as
3023 threatened or endangered under the ESA [see section 10(a)(1)(A)]... In exchange for actions that
3024 contribute to the recovery of listed species on non- Federal lands, participating property owners
3025 receive formal assurances from the Service that if they fulfill the conditions of the SHA, the
3026 Service will not require any additional or different management activities by the participants
3027 without their consent. In addition, at the end of the agreement period, participants may return
3028 the enrolled property to the baseline conditions that existed at the beginning of the SHA.”

3029 There are two SHAs covering Northern Spotted Owl in California, Forster-Gill, Inc., and The Fred M. van
3030 Eck Forest Foundation.

3031
3032 *Forster-Gill, Inc., Safe Harbor Agreement*
3033

3034 The Forster-Gill SHA was issued in June 2002 has a 90-year term, and consists of 236 acres in Humboldt
3035 County one mile north of the town of Blue Lake (USFWS 2002). The majority of the property (91%)
3036 contains young growth coastal redwood (30-35 years old), with 216 acres containing WHR type 4D (12-
3037 24 inch dbh and 60-100 percent canopy closure). At the time of the SHA issuance two owl activity
3038 centers were adjacent to the property, both associated with one pair.

3039 In the SHA, Forster-Gill agrees to enhance and maintain approximately 216 acres of forested Northern
3040 Spotted Owl habitat through timber harvest management designed to create uneven-aged stands with
3041 large tree components, characteristic of high quality owl habitat. Specifically, the SHA will:

- 3042
- 3043 • Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
 - 3044 • Retain all snags not posing a hazard risk.
 - 3045 • Conduct annual owl surveys on property and within a 500 foot radius around the property.
 - 3046 • Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
 - 3047 • Ensure no harvest occurs within 1,000 ft of any active owls nest site.
 - 3048 • Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single
3049 tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and
3050 approved by USFWS.
 - 3051 • Conduct timber stand inventories and provide USFWS with data.
 - 3052 • Allow USFWS or other agreed-upon party access to property for monitoring and management
3053 activities.

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The Fred M. van Eck Forest Foundation Safe Harbor Agreement

The van Eck Foundation SHA was issued in August 2008 has a 90-year term, and covers management activities on 2,163 acres of land in Humboldt County owned by The Fred M. van Eck Forest Foundation (USFWS 2008a). Four management units are identified, of which three (Lindsay Creek, Squaw Creek and Fieldbrook) are located in the Lindsay Creek watershed about one mile of the town of Fieldbrook. The fourth unit, Moonstone, is located in the about ½ mile east of the community of Westhaven. The main forest types found include redwood, Douglas-fir, grand fir, western hemlock, and Sitka spruce. Approximately 80% of the land contains nesting and roosting habitat, with dense canopy cover, and trees over 16 inch dbh. At the time of SHA issuance, no Spotted Owl nesting was documented, however roosting single and pairs were.

The SHA incorporates the terms of the conservation easement granted to Pacific Forest Trust (PFT) in 2001. The conservation easement includes performance goals and restrictions that create forest component recognized as high quality owl habitat.

In the SHA, van Eck Foundation agrees to maintain and protect 6.5 acres of nesting and roosting habitat surrounding an AC, and limit harvesting to single-tree selection or group selection with a target of retaining native species and trees that grow vigorously. Exceptions will be made for trees that have been identified for snag or wildlife tree retention. Canopy cover will remain above 80% (averaged across the stand) upon completion of harvesting activities. Specifically, the SHA will:

- Comply with the conservation strategy, including management performance goals, restrictions on harvest, and road construction and maintenance conditions.
- Retention of all snags not posing a safety hazard.
- Conduct protocol-level surveys and determine reproductive status on property and within 500 foot radius off property, with annual surveys at Lindsay Creek, Squaw Creek, and Fieldbrook units, and one year prior to harvesting activities at Moonstone unit.
- Implement protection measures for up to five activity centers.
- Conduct following protection measures: maintain a 300 foot no-harvest-buffer on up to two activity centers, maintain a 100 foot limited-harvest-buffer on up to three activity centers, no harvest operations to occur within 1,000 feet of any activity center during the breeding season, and no harvest of any known owl nest trees.
- Cooperate with USFWS on Barred Owl control measures.
- Submit timber inventory reports according to management units
- Allow the USFWS or other agreed-upon party, access to property.
- Conduct annual protocol-level surveys and determine reproductive status and success at owl nest sites found for a minimum of three years post-harvest.

Exemption Harvest

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3092 Exemption harvest is meant to assist private landowners wanting/needing to remove trees and may
3093 allow the removal to be exempt from the THP process. The different types of exemptions available
3094 include:

- 3095 • Forest Fire Prevention Exemption
- 3096 • Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption
- 3097 • Less Than Three Acre Conversion Exemption
- 3098 • Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption
- 3099 • Public Agency, Public and Private Utility Right of Way Exemption
- 3100 • Woody Debris and Slash Removal Exemption
- 3101 • Removal of Fire Hazard Tree within 150 feet of a Structure Exemption
- 3102 • Drought Mortality Amendment Exemption 2015
- 3103 • Protection of Habitable Structures Exemption 2015

3104
3105 Any of the above mentioned exemptions may impact Northern Spotted Owls either directly through
3106 habitat removal or indirectly through noise or visual disturbance, depending on the location and on the
3107 yearly timing of operations

3108 Exemption harvest operations must comply with all aspects of the Forest Practice Rules and various
3109 restrictions regarding the operations under the various emergency conditions. In exemption harvest
3110 actions, no known sites of rare, threatened or endangered plants or animals are to be disturbed,
3111 threatened or damaged. However, Northern Spotted Owl protocol-level surveys and habitat
3112 assessments are not generally required by the Forest Practice Rules to operate under an exemption.

3113 Not all exemptions require an RPF certification. Those that do not require the certification are:
3114 Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption, the Public Agency,
3115 Public and Private Utility Right of Way Exemption, Drought Mortality Amendment Exemption and the
3116 Removal of Fire Hazard Trees within 150 feet of a Structure Exemption.

3117 The Christmas Tree/Dead, Dying or Diseased Fuel wood or Split Products Exemption has been available
3118 during the entire time period in which the Northern Spotted Owl has been listed as threatened by the
3119 USFWS. Tree removal is limited to less than 10 percent of the average volume per acre and can be
3120 applied to an entire ownership on any size.

3121 The Forest Fire Prevention Exemption allows the harvest of green merchantable trees, but the logging
3122 area is limited to 300 acres in size and a statement of the postharvest stand stocking level is required as
3123 required in 1038(i) in the Forest Practice Rules.

3124 The Less Than Three Acre Conversion Exemption is applicable to a conversion of timberland to a non-
3125 timber use only, of less than 3 acres in one contiguous ownership, whether or not it is a portion of a
3126 larger land parcel and shall be not part of a THP. Within one month of the completion of timber
3127 operations, including slash disposal, the timberland owner shall submit a work completion report to CAL
3128 FIRE.

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3129 The Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption is not limited to 10% of
3130 the volume per acre and the landowner must notify CAL FIRE of the completion of timber operations
3131 within 30 days of their cessation.

3132 The Public Agency, Public and Private Utility Right of Way Exemption , working with Public Resources
3133 Code section 4628 and Forest Practice Rules section 1104.1(b) exempts public agencies from the
3134 requirement to file an application for timberland conversion or a THP when they construct or maintain
3135 rights of way on their own property or that of another public agency. This exemption extends to
3136 easements over lands owned in fee by private parties. This exemption is not available for rights of way
3137 granted from one private landowner to another.

3138 The Woody Debris and Slash Removal Exemption allows the removal of woody debris and slash that is:
3139 (1) located outside the WLPZ, (2) within the reach of loading equipment operating on existing roads and
3140 landings, (3) developed during timber operations, (4) delivered as combustion fuel for the production on
3141 energy, and (5) in compliance with the conditions of Forest Practice Rules section 1038 subdivision (b)
3142 paragraphs (3),(4),(6),(7),(8) and (10).

3143 The Removal of Fire Hazard Trees within 150 feet of a Structure Exemption allows only trees within 150
3144 feet of an approved and legally permitted structure that complies with the California Building Code
3145 (includes only structures designed for human occupancy, garages, barns, stables and structures used to
3146 enclose fuel tanks) may be harvested under this Notice of Exemption.

3147 The Drought Mortality Exemption was adopted in 2015 by the Board of Forestry due to the prolonged
3148 drought and supercedes the provisions of any other exemption in the same harvest footprint (harvesting
3149 of dead and dying trees). Trees that are dead or trees with fifty percent or more of foliage-bearing
3150 crown that is dead or fading in color are eligible for removal. Under this exemption, it is required to
3151 retain an average for the harvest area of not less than one decadent and deformed tree of value to
3152 wildlife, snag or dying tree per acre that is greater than sixteen inches diameter breast height and
3153 twenty feet tall. This provision does not apply within 100 feet of habitable structures, roads, fire
3154 suppression ridges and infrastructure facilities such as transmission lines and towers or water
3155 conveyance and storage facilities. This exemption requires an RPF signature when timber operations on
3156 a cumulative harvest area exceed twenty acres per total ownership.

3157 The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to
3158 the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet
3159 from any point of an habitable structure that complies with California Building Code for the purpose of
3160 reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily
3161 comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the
3162 treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2,
3163 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project
3164 area shall be increased in the post-harvest stand.

3165 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3166 approximately 41,767,250 acres (1992 to 2013) have been exempted for harvest in counties within the

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range of Northern Spotted Owl (CAL FIRE 2014). These acres do not represent operational acres (actual acres harvested) but only notification acres (possible intended acres harvested). Operational acre reporting is not required; therefore there is no data representing the precise amounts or locations of areas harvested under an exemption. Some of these acres are most likely outside the known range of the Northern Spotted Owl. In addition, some landowners prepare notifications for their entire ownership yearly; yet may only operate on only a small area, thereby possibly compounding this acreage total.

Volume of timber removed under an exemption is reported to the Board of Equalization (BOE), and is another way to assess levels of exemption harvest. With the precise location and yearly timing of the volume reported unknown, specific impact assessments cannot be developed. However, the total volume harvested, average volume amounts by each county and total percentage of harvest volume may be enough to determine that more information is needed. Yearly exemption harvest volume from the counties within the known Northern Spotted Owl range date back to 1990 and average approximately 49,456 MBF (1,000 board-foot) and represent approximately 4.87% of total volume harvested. The highest total amount harvested occurred in 1994 totaling 164,232 MBF, accounting for 15% of the total volume harvested that year. The total exemption volume harvested during the time that Northern Spotted Owl has been listed as threatened by the USFWS is 1,186,954 MBF. The largest amount of exemption volume recorded is from Shasta in 1994 totaling 79,993 MBF, with the largest percentage of total volume coming from Napa (1994), Marin (1996), Glenn (2003), and Lake (2005), where 100% of the total volume harvested was exemption volume (BOE 2014). These volume amounts do not include all volume as the BOE reporting requirements only require volume reporting when \$3000.00 is obtained. The BOE does not track the volume that is less than \$3000.00 in value (A. Tenneson, personal communication, November 18, 2015).

It is not known if the long-term exemption harvesting on private lands in California is limiting Northern Spotted Owl populations, but exemption harvesting may reduce well defined/ critical habitat elements over time. The current exemption harvest process does not require owl habitat analysis or surveys and may directly impact Northern Spotted Owl, and therefore more information is needed to fully assess the impacts from exemption harvest.

Emergency Harvest

Private landowners may cut or remove timber under an emergency basis if “emergency conditions” exist pursuant to Forest Practice Rules section 895.1. Emergency conditions are defined as, “... those conditions that will cause waste or loss of timber resources to the timber owner that may be minimized by immediate harvesting of infected, infested or damaged timber or salvaging down timber; or those conditions that will cause appreciable financial loss to the timber owner that may be minimized by immediate harvesting of timber.”

Types of emergency conditions include:

- Dead or dying trees as a result of insects, disease, parasites, or animal damage.

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3205 • Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood,
3206 landslide, or earthquake.
3207 • Dead or dying trees as a result of air or water pollution.
3208 • Cutting or removing trees required for emergency construction or repair of roads.
3209 • Cutting and removal of hazardous fuels.
3210 • Treatments to eradicate an infestation of Sudden Oak Death.
3211
3212 There is some overlap with types of emergency conditions between Exemption and Emergency harvests.
3213 Exemption Harvest allows only 10% of volume of “dead and dying trees” to be removed, while under an
3214 Emergency Harvest the minimum stocking standards need to be met and does not allow the harvest of
3215 merchantable sawlogs. In addition, Emergency Harvests allow removal of dead trees or trees instituting
3216 an obvious large scale economic loss, whereas Exemption Harvest does not.

3217 Emergency Harvest operations must comply with all aspects of the Forest Practice Rules specific to
3218 emergency operations (Forest Practice Rules § 1052 subd. (a)). Before cutting or removing timber on an
3219 emergency basis, an RPF on behalf of a timber owner or operator must submit a Notice of Emergency
3220 Timber Operations. In Emergency Harvest, no known sites of rare, threatened or endangered plants or
3221 animals are to be disturbed, threatened or damaged. However, Northern Spotted Owl protocol-level
3222 surveys and habitat assessments are not generally required to operate during emergency conditions.

3223 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3224 between 1992 and 2013 approximately 344,542 acres (CAL FIRE 2014) have been notified for emergency
3225 harvest in counties within the owl’s range. These acres may not represent operational acres (actual
3226 acres harvested) but only notification acres (intended acres harvested). Depending on the emergency
3227 condition and stocking requirement, operational acre reporting may not be required; therefore there is
3228 no acreage data or mapping data representing the precise amounts or locations for all emergency
3229 operational areas.

3230 Emergency harvest operations mostly occur in areas where forest stand conditions are dead or fallen,
3231 forest habitat conditions not meeting the definitions of suitable habitat for Northern Spotted Owl under
3232 the Forest Practice Rules, however indirect impacts may occur as a result of the emergency operation.
3233 The emergency notification data is compiled yearly by county, therefore Northern Spotted Owl range-
3234 specific data is not available. Of the total notification acres between 1992 and 2013, some are most
3235 likely outside the known range of the Northern Spotted Owl as the known range line does not include all
3236 of the county area within this acreage data set.

3237 It is not known if the long-term emergency harvesting on private lands in California is limiting Northern
3238 Spotted Owl populations, however, there is some evidence that salvage logging effects use of burned
3239 areas by Spotted Owls. See the discussion of wildfire in the Threats section for additional discussion on
3240 this type of emergency harvest. Some indirect impacts, such as noise disturbance, may be occurring as a
3241 result of emergency operations but level and extent of this potential impact is not well documented.
3242 More information is needed to fully assess the impacts to Northern Spotted Owl from emergency
3243 harvesting.

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Other Management Actions

Forest Certification Programs

Some private landowners in California have voluntarily worked with organizations to achieve certification for their forest landholdings and forestry practices. There are numerous organizations that certify forest products, with Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) being two of the largest. In order for a landowner to attain certification, they must achieve certain conservation requirements and initiate specific management activities to meet these requirements. For example, a landowner may be required to increase retention in even-aged units, and to achieve this 10-30% of the pre-harvest basal area might be retained in a clumped or dispersed fashion. Another example that could benefit Northern Spotted Owl would be protection of old-growth and legacy trees through the creation of policy and planning documents that ensure their identification and protection (T. Bolton, personal communication, September 5, 2014).

The FSC conducts audits to ensure compliance with FSC certification. In addition, the FSC certification has geographic-specific indicators for the US and Pacific Coast region (FSC 2010a, S. Chinnici, personal communication, September 3, 2014) and has developed a draft framework for assessing “High Conservation Value Forests” (HCVFs) to help land managers identify lands with high conservation value (FSC 2010b). Lands determined to be of high conservation value have extra requirements for monitoring. Conserving these lands enables landowners to get credit for conservation while being able to manage other parts of their land for timber products (FSC 2010a).

The Department does not have an accounting of the number of acres of timberland covered by a forest certification program, nor the quality of the management activities required to meet certification. Therefore, there is not enough information available to suggest what kind of impact, if any, forest certification has had on Northern Spotted Owl populations. However, certification programs may have a positive effect on Northern Spotted Owl in cases where more foraging, nesting, or roosting habitat is maintained than that called for in the Forest Practice Rules.

Conservation Easements

Most of the conservation easements in forested environments within the Northern Spotted Owl range allow for some sort of timber harvest. The Department is involved in only a portion of easement/title projects, and of these projects, the Department is typically not a landowner, title-holder, or manager of these lands. While working with landowners and managers on the easement/title conditions, the Department Lands Program staff suggests conditions conducive to the protection and conservation of wildlife and their habitats.

Due to the variability of landowner needs, the conditions agreed upon for easements constitute a wide range of habitat protection. Thus, it is difficult to draw conclusions as to how easements/titles are contributing to Northern Spotted Owl conservation. Additionally, these areas are not rigorously studied specific to the Northern Spotted Owl.

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State Forests

CAL FIRE operates eight Demonstration State Forests in California, totaling about 71,000 acres. A majority of these forests are actively managed as timberlands and annually produce on average about 30 million board feet of wood. About 53,145 actively-managed acres of State Forest lands occur within the range of the Northern Spotted Owl; this includes Ellen Pickett State Forest (158 acres), Las Posadas State Forest (843 acres), Boggs Mountain Demonstration State Forest (3,425 acres), and Jackson Demonstration State Forest (48,719 acres). State Forests are intended to be used for experimentation and demonstration of various silvicultural methods for their economic and environmental/scientific value. The State Forests have management plans that are periodically reviewed by BOF and all timber harvesting activities on State Forests must comply with the Forest Practice Act and the Forest Practice Rules, including the measures to avoid take of Northern Spotted Owl found in Forest Practice Rules sections 919.9 and 919.10.

Jackson Demonstration State Forest (JDSF) is the largest of the eight forests (49,000 acres) and represents nearly 70% of the total State Forest acreage in California. This forest has been managed and harvested since 1862 and was acquired by the State in 1947. Located in central Mendocino County, the forest consists primarily of coast redwood and Douglas-fir, with some old-growth coast redwood remaining. Forest stands on JDSF have been managed on an even-aged and uneven-aged basis under various silvicultural systems; however, special restrictions are put on even-aged management and clear-cutting (CDF 2008, CDF 2014).

The JDSF Management Plan (CDF 2008) contains a Northern Spotted Owl Conservation Strategy, with the goal to “maintain or increase the number and productivity of nesting owl pairs through forest management practices that enhance nesting and roosting opportunities and availability of a suitable prey base.” CAL FIRE monitors certain Northern Spotted Owl activity centers on JDSF and the Management Plan conditions are nearly identical to the Forest Practice Rules.

State Parks

The California Department of Parks and Recreation (CA State Parks) manages 280 park units in California; 64 of these park units are within the range of the Northern Spotted Owl, totaling 214,286 acres. CA State Parks’ mission, in addition to preserving biodiversity, includes protecting cultural resources and creating recreation opportunities. CA State Parks does not have a management plan for the Northern Spotted Owl and management for species occurs at the park unit scale. Each park unit prepares a general plan that describes the range of activities occurring within the park unit and resource protection that the park unit enables.

The largest State Park (SP) in the Northern Spotted Owl range, Redwood National and State Parks, is jointly managed by the NPS and CA State Parks and includes: Redwood National Park, Jedediah Smith Redwoods SP, Del Norte Coast Redwoods SP, and Prairie Creek Redwoods SP. RNSP does not have specific Northern Spotted Owl management actions in its General Management Plan/General Plan, but does have vegetation management actions for old-growth, second-growth, prairie and fires. Old-growth forests are protected, managed, and restored to provide habitat for species and to reduce fire hazards.

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3323 Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to
3324 reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak
3325 woodlands and prairies is managed through tree removal and burning. Nine management zones within
3326 the RNSP delineate the degree of human influence and development on that can occur on the landscape
3327 (NPS 2000a).

3328 Similar to Redwood National and State Parks, the second largest park unit within the Northern Spotted
3329 Owl range, Humboldt Redwoods State Park, does not engage in specific management activities for
3330 Northern Spotted Owl, but protects and manages for old-growth stands to be sustained over time (CDPR
3331 2001).

3332 California State Parks do not engage in regular surveys for Northern Spotted Owl within State Parks,
3333 though surveys sometimes occur before park projects are started. However, adjacent timberland
3334 owners routinely survey Northern Spotted Owl activity centers within State Parks (T. Fuller, personal
3335 communications, September 2, 2014).

3336 *University of California Natural Reserves*

3337
3338 Comprised of more than 756,000 acres across 39 sites and representing most major California
3339 ecosystems, the UC Natural Reserve System (UCNRS) is the largest university-administered reserve
3340 system in the world. By supporting university-level teaching, research, and public service, the UCNRS
3341 contributes to the understanding of and wise stewardship of California's natural resources. Five UCNRS
3342 sites (totaling 4,625 acres) across California occur within the range of the Northern Spotted Owl, though
3343 there are no management plans or Northern Spotted Owl SO data for individual reserves (UC 2014).
3344 Angelo Coast Range Reserve has had three Northern Spotted Owl territories through since the late-
3345 1980s, but since Barred Owls were detected in the area starting in 1999 Spotted Owls have not been
3346 detected at any of the three sites (A. Franklin, personal communication, March 23, 2015).

3347 *Department Ecological Reserves*

3348
3349 Authorized by the California Legislature in 1968 and administered by the Department, the ecological
3350 reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats,
3351 and to provide areas for education and scientific research. The system now encompasses 119 properties
3352 totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur
3353 within the range of the Northern Spotted Owl; however there are no management plans for the system
3354 or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception
3355 is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by
3356 BLM, which manages for late seral habitat benefiting Spotted Owls.

3357 *Fisheries Restoration Grant Program*

3358 As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern
3359 Spotted Owls and their habitat are required for each project funded. The purpose of FGRP is to support
3360 restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must

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3361 provide a detailed proposal that thoroughly addresses all criteria of the FGRP, one of which is avoidance
3362 and minimization measures for Northern Spotted Owls if a project proposes to conduct work in owl
3363 habitat. The geographic area covered by FGRP almost completely overlaps with the Northern Spotted
3364 Owl range in California, therefore the potential for a project be in owl habitat is high. Once a project is
3365 approved, the proponent must obtain a Lake or Streambed Alteration Agreement (LSAA) from the
3366 Department to comply with the CEQA. The LSAA will include conditions for the protection of wildlife and
3367 habitat, and must be followed during project activities.

3368 To avoid potential impacts to Northern Spotted Owls FRGP projects must adhere to the following, as
3369 noted in the LSAA:

- 3370 • Work with heavy equipment at any site within 0.25 miles of suitable habitat for the Northern
3371 Spotted Owl shall not occur from November 1 to July 9.
- 3372 • The work window at individual work sites may be advanced prior to July 31, if protocol surveys
3373 determine that suitable habitat is unoccupied.
- 3374 • If these mitigation measures cannot be implemented or the project actions proposed at a
3375 specific work site cannot be modified to prevent or avoid potential impacts to Northern Spotted
3376 Owls or their habitat, then activity at that work site will be discontinued and the project
3377 proponent must obtain incidental take authorization from the USFWS.
- 3378 • For projects contained within streams and watersheds included in a USFWS Habitat
3379 Conservation Plan the mitigation measures contained within those Habitat Conservation Plans
3380 shall be followed.

3381 The grant program is very successful and funds numerous projects each year. In fiscal year 2013/2014
3382 alone, FRGP funded approximately \$16.5 million dollars in 56 projects, of which 44 projects were located
3383 within the range of the Northern Spotted Owl.

3384 **Threats (Factors Affecting Ability to Survive and Reproduce)**

3385

3386 **Historical Habitat Loss and Degradation**

3387 *Historical Habitat Loss*

3388 Historical (pre-logging) variability in forest age and structure in the range of the Northern Spotted Owl
3389 was controlled by natural processes, including wildfires (Courtney et al. 2004). Estimates of pre-logging
3390 extent of old forest in western Washington and Oregon are relatively consistent and range from 60 to
3391 72% of the landscape (Courtney et al. 2004). When the USFWS listed the Northern Spotted Owl as
3392 threatened in 1990, estimates of historical Spotted Owl habitat loss ranged from 60 to 88% loss
3393 rangewide since the early 1800s (USFWS 2011a). Much of this loss was attributed to timber harvest and
3394 to land-conversion, and was concentrated mostly at lower elevations and in the Coast Ranges (USFWS
3395 2011a). This pattern of historical loss is apparent in the current distribution of suitable habitat, with

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3396 large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat
3397 (see Figure 4).

3398 Prior to 1990, the annual rate of removal of Spotted Owl habitat on national forests as a result of logging
3399 had been about 1% per year in California and 1.5% per year in Oregon and Washington (USFWS 1990,
3400 2011). At the time, it was projected that future rates of habitat removal would eliminate all nesting and
3401 roosting habitat on non-protected BLM lands in Oregon, with the exception of the Medford District, by
3402 the year 2016 (USFWS 1990). Estimates from the decades before 1990 indicate that harvest rates on
3403 private industrial lands were consistently about twice the average rate of harvest on public land (Cohen
3404 et al. 2002). Regarding harvest rates on private industrial and non-industrial lands, Bigley and Franklin
3405 (2004) estimated harvest rates in the late 1980s and early 1990s for private industrial land of 2.4% per
3406 year, and harvest rates on non-industrial lands increased from 0.2% in the 1970s to a rate similar to that
3407 of the private industrial lands by the early 1990s.

3408 *Assessing Habitat Loss through Implementation of the Northwest Forest Plan*

Comment [ABF88]: This title seemed a bit misleading in that it implied that the NWFP was responsible for habitat loss. Maybe retitle simply as "Habitat Loss under the Northwest Forest Plan"

3409 The Northern Spotted Owl was listed under the federal Endangered Species Act in 1990 in part because
3410 of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised
3411 recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls,
3412 ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or degradation from stand
3413 replacing wildfire and other disturbances, and loss of amount and distribution of Spotted Owl habitat as
3414 a result of past activities and disturbances (USFWS 2011a). To address ongoing decline of Northern
3415 Spotted Owl habitat across the range, the NWFP established reserved lands including late-seral reserves,
3416 adaptive management reserves, congressionally reserved lands, managed late-successional areas, and
3417 larger blocks of administratively withdrawn lands (USDA and USDI 1994) (Figure 11). These are described
3418 in more detail above. It was assumed that habitat in reserves would improve over time as successional
3419 processes led to more mature forests, however, this is a slow process and so recruitment of habitat
3420 conditions on reserves was expected to take many decades. It was also assumed that habitat outside of
3421 reserves would continue to decline due to timber harvest and other disturbances but that dispersal
3422 habitat would be maintained in order to facilitate movement between reserve lands. Given the
3423 continued Northern Spotted Owl population declines and the increasing threat of the Barred Owl, the
3424 revised recovery plan recommended conserving occupied sites and unoccupied, high-value Spotted Owl
3425 habitat on state and private lands wherever possible (USFWS 2011a).

3426 In order to understand the degree to which the NWFP contributes to conservation of owl habitat, the
3427 rangewide trends in habitat are regularly assessed. To date, assessments have been performed at the
3428 10-year and 15-year time points (Davis and Lint 2005, Davis et al. 2011). The recent assessment
3429 estimated rangewide habitat changes on federal and nonfederal lands from 1994 through 2007 for
3430 California and from 1996 through 2006 in Oregon and Washington by comparing vegetation maps for
3431 two bookend time periods. In addition to rangewide changes, trends for each physiographic province
3432 and for each state are also reported (Davis et al. 2011). The assessment tracks changes in Northern
3433 Spotted Owl nesting and roosting habitat, and also tracks changes in dispersal habitat within and

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3434 between the reserves. Foraging habitat is not assessed through modeling for the NWFP. Nesting and
3435 roosting habitat maps were produced through habitat suitability modeling using several forest structure
3436 variables (e.g., percent conifer cover, average conifer dbh, average stand height) and a forest age
3437 variable (Davis et al. 2011). Vegetation stands were placed in one of four categories (highly suitable,
3438 suitable, marginal, and unsuitable), with highly suitable and suitable categories assumed to represent
3439 nesting and roosting habitat (Davis et al. 2011). To assess change, an area was considered to have lost
3440 nesting and roosting habitat if its condition moved from suitable or highly suitable to marginal or
3441 unsuitable.

3442 Although federal lands contain less than half of the total forest land within the entire range of the
3443 Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and
3444 roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and
3445 roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands
3446 lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal
3447 lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance
3448 (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost
3449 on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the
3450 fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl
3451 range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands
3452 has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only
3453 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on
3454 nonreserved lands.

3455 Conversely, on nonfederal lands most of the nesting and roosting habitat loss was due to harvest (about
3456 625,600 acres; 14.9%). On nonfederal lands in Oregon and Washington, the extent of older forest
3457 harvested annually declined following implementation of the NWFP. However, this decline was likely
3458 due to exhaustion of the available inventory, as the annual harvest rate stayed relatively steady when
3459 measured as a percentage of the remaining older forest (Healey et al. 2008). A relatively small amount
3460 of nesting and roosting habitat on nonfederal lands was lost to fire, insects, and disease (0.6%; about
3461 23,700 acres).

3462 Relative rates of nesting and roosting habitat loss on federal vs. nonfederal lands in California follow the
3463 rangewide pattern. Consistent with the entire subspecies range, loss of nesting and roosting habitat on
3464 federal lands in California was mostly due to wildfire and other natural disturbances (4.2%; 77,500
3465 acres), with a higher rate of loss than on federal lands rangewide (2.8%) (Davis et al. 2011). Most of the
3466 loss to natural disturbance in California occurred in the Klamath Province (73,200 acres), with almost all
3467 of the loss due to wildfire (Davis et al. 2011). Harvest rate of nesting and roosting habitat on federal
3468 lands in California was fairly low and matched that of federal lands rangewide (0.6%; 11,200 acres),
3469 although 3.0% of the nesting and roosting habitat on federal lands in the California Cascades Province
3470 was harvested (6,500 acres), which was the highest rate of harvest on federal lands across all provinces
3471 rangewide (Davis et al. 2011).

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3472 As with the rangewide pattern, nonfederal lands in California experienced much greater loss of nesting
3473 and roosting habitat to harvest than to natural disturbance. The acreage of nesting and roosting habitat
3474 harvested on non-federal lands in California was about 90,200 acres (5.8%), which exceeds the total
3475 amount of habitat loss on federal lands in California (Davis et al. 2011). This is consistent with the
3476 rangewide pattern showing that the bulk of total nesting and roosting habitat loss has been due to
3477 harvest on nonfederal lands; although the majority occurred in Washington and Oregon, more nesting
3478 and roosting habitat was lost to harvest on non-federal lands (about 625,600 acres) rangewide than
3479 total loss on federal lands from harvest and natural disturbance combined (about 298,600 acres total)
3480 (Davis et al. 2011). California has more nesting and roosting habitat on nonfederal lands than either
3481 Washington or Oregon but has lost relatively less due to harvest, with Washington and Oregon losing
3482 18.6% and 21.8%, respectively, compared to 5.8% in California (Davis et al. 2011). This is likely due to
3483 differences in habitat retention requirements in the regulations of each state. On nonfederal lands in
3484 California, nesting and roosting habitat loss to natural disturbance was relatively low at 0.4% (about
3485 7,500 acres) (Davis et al. 2011).

3486 Davis et al. (2011) estimated amount of dispersal habitat across the range of the Northern Spotted Owl
3487 at the start of the NWFP and at the end of the study period (2006 or 2007 depending on location) by
3488 querying GIS vegetation databases for forests with conifer dbh ≥ 11 inches and conifer cover $\geq 40\%$ (see
3489 Figure 5). This is similar to the definition of minimum dispersal habitat from Thomas et al. (1990).
3490 Modeled nesting and roosting habitat was also included in the mapped dispersal habitat because owls
3491 will disperse through forests meeting the requirements of nesting and roosting habitat. Trends in
3492 dispersal habitat over the study period were analyzed within and between federal reserved lands. The
3493 distribution of “dispersal-capable” habitat was also mapped by combining results of the mapped
3494 dispersal habitat with estimates of maximum dispersal distance from Forsman et al. (2002) (Figure 17).
3495 This estimate of dispersal-capable habitat on the landscape allowed for a measure of the ability of owls
3496 to disperse between habitat reserves, which is a goal of the NWFP and an important functional measure
3497 of habitat beyond a simple acreage estimate of total dispersal habitat.

Comment [ABF89]: See my General Comment 1 under the THREATS section.

3498 Increases in dispersal habitat, as defined by conifer forests exceeding 11 inches dbh and 40% canopy
3499 cover, occurred through forest succession and through partial disturbance of nesting and roosting
3500 habitat to smaller, more open forest. Recruitment of dispersal habitat exceeded loss rate for a net
3501 increase of 5.2% rangewide (Davis et al. 2011). However, given the distribution of habitat increases and
3502 losses, the dispersal-capable habitat on the landscape decreased by about 1% (Davis et al. 2011); on
3503 federal lands this loss was largely due to wildfire (Figure 18). Losses of dispersal-capable habitat
3504 occurred mostly around the periphery of federal forests; Davis et al. (2011) suspect this is due to timber
3505 harvesting on nonfederal lands that border federal lands. Gains in dispersal-capable habitat also often
3506 occurred at the periphery of federal forests, as forest succession in younger or recently harvested
3507 forests led to forests meeting the minimum dispersal requirements.

3508 The network of large federal reserves across the range of the Northern Spotted Owl is fairly well
3509 connected, although there are exceptions in the Olympic Peninsula, the eastern Washington Cascades,
3510 and in the southern end of the range in California. The Marin County population is poorly connected to

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3511 other federal reserves, and large portions of the California Coast physiographic province are mapped as
3512 having poor dispersal-capability. However, the definition of minimum dispersal habitat in Thomas et al.
3513 (1990) and used to map trends in the NWFP may not capture the full range of dispersal habitat
3514 conditions in Northern California, where Northern Spotted Owls use younger forests (USFWS 2011a).

3515 **Timber Harvest**

3516 *Timber Harvest on Private Land*

3517 The Northern Spotted Owl was federally listed as Threatened in 1990 larger due to extensive habitat loss
3518 from timber harvest activities on federal and nonfederal land. In 1991, the California Forest Practice
3519 Rules sections 919.9 [939.9] and 919.10 [939.10] were enacted, which describe options and procedures
3520 that can be used in THPs to avoid take of Northern Spotted Owl or to proceed under incidental take
3521 authorization. Compliance with the Forest Practice Rules apply to all commercial timber harvesting
3522 operations for private landowners (excluding specific exemptions discussed in the Timber Harvest
3523 Management section of this report) from small parcels operations to large timber operations. Forest
3524 Practice Rules 919.9[939.9] specify subsections (a) through (g), which give the landowner options among
3525 which to select and follow for timber harvest within the range of the Northern Spotted Owl.

3526 THPs are plans submitted by the landowners that serve as the environmental review document and they
3527 outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent
3528 damage to the environment, including impacts to Northern Spotted Owl activity centers. NTMPs are
3529 plans meant to promote the long term management and planning on forest ownerships of 2,500 acres
3530 or less, and they allow an alternate to submitting individual THPs prior to harvest. Landowners with
3531 approved NTMPs agree to manage their forests through uneven-aged management and long-term
3532 sustained yield.

3533 As detailed in the Timber Harvest Management section of this report, the Department evaluated a
3534 subset of THPs and NTMPs submitted that fell within the range of the Northern Spotted Owl. Evaluation
3535 effort for each plan type varied depending on time constraints and level of information that was readily
3536 available, and included a summary of number of THPs submitted, types of silvicultural methods most
3537 used, and acres of habitat proposed for harvest and retention. For THPs, all plans submitted in 2013
3538 were evaluated, and a subset of Northern Spotted Owl activity centers from plans utilizing Option (e)
3539 and (g) (the most commonly used options from Forest Practice Rules 919.9[939.9]) were followed back
3540 in time to summarize cumulative harvest activities impacting the owl sites. For NTMPs, plans submitted
3541 within interior counties from 1991-2014 were evaluated, and plans submitted within coastal counties
3542 from 2005-2014 were evaluated.

3543 Within the interior THPs evaluated, the Alternative method was proposed more than any other method,
3544 covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total
3545 acreage. An Alternative silvicultural prescription can be included in a timber harvest plan when an
3546 alternative regeneration method or intermediate treatment is more effective or more feasible than any
3547 of the standard silvicultural methods (see Appendix 1). For plans using the Alternative method in the

Comment [ABF90]: In terms of California, I think you need to clarify whether these are coastal (e.g. redwoods), interior (e.g., Douglas Fir, etc.) or both.

Comment [ABF91]: A lot of this section seems to be a repeat from the Existing Management section.

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interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the Alternative method used. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more area than all other methods combined. Forest Practice Rules Section 913.4(d) defines Variable Retention as an approach to harvesting based on the retention of structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for integration into the post-harvest stand to achieve various ecological, social and geomorphic objectives (see Appendix 1).

Of the NTMPs evaluated, Selection, Group Selection, and Uneven-aged silvicultural methods are the most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection, Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Uneven-aged management means the management of a specific forest, with the goal of establishing a well-stocked stand of various age classes which permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop (see Appendix 1). Most NTMPs evaluated that used the Uneven-aged silvicultural method did not delineate acres that would fall under each category, therefore there is limited ability to assess the type of harvest applied on the landscape. Under the Selection and Group Selection methods, the trees are removed individually or in small groups sized within areas of 0.25 to 2.5 acres.

Types of silvicultural practices vary on the landscape and may impact Northern Spotted Owls differently depending on a variety of factors surrounding type and extent of habitat removed. For example Clear Cut harvesting (removal of an entire stand in one harvest), depending on how it is applied on the landscape, has a potential to negatively impact Northern Spotted Owls. Impacts from harvest have been recognized in the literature since the time the owl was federally listed (UFWs 2011a). Yet implementation of other frequently used silvicultural methods (e.g., Alternative, Variable Retention, Group Selection, Uneven-aged) have less obvious impacts to Northern Spotted Owl foraging, nesting, and roosting habitat. Some harvest methods may serve to reduce habitat quality by removing key components of owl habitat near Northern Spotted Owls activity centers. For example, thinning has been shown to decrease the abundance of Northern Flying Squirrels and Red Tree Voles, two important prey species for Northern Spotted Owls (Wilson and Forsman 2013). Alternatively, applied at appropriate scales, some methods may in fact serve to enhance owl habitat, for example, by increasing foraging opportunities. Given the potential of both negative and positive impacts to the Northern Spotted Owl, more thorough documentation and rigorous evaluation of harvest type and actual harvest levels of foraging, nesting, and roosting habitat, within harvest plans are needed. In addition, research is needed to provide a clearer understanding of the effects of silvicultural practices on important prey species habitat.

To evaluate the level of impact of proposed harvest and retention to Northern Spotted Owl activity centers, each interior and coastal THP utilizing Option (e) and Option (g) in 2013 within the region was assessed further. Retention and harvest were assessed at two scales for interior THPs: within 0.5 miles and between 0.5 and 1.3 miles of an activity center. For coastal THPs, retention and harvest was only assessed within 0.7 miles of an activity center. For THPs utilizing Option (e), foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within

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3588 0.5-1.3 miles). On the coast, foraging and nesting/roosting were retained at relatively similar levels
3589 within 0.7 miles (52,817 acres of foraging and 47,344 acres of nesting and roosting). For interior THPs
3590 utilizing Option (g) nesting/roosting (1,388 acres within 0.5 miles and 3,879 acres within 0.5-1.3 miles)
3591 and foraging habitat (1,032 acres within 0.5 miles and 3,171 acres within 0.5-1.3 miles) were similarly
3592 proposed for retention, and within the coast, more nesting/roosting habitat was retained (2,763 within
3593 0.7 miles).

3594 Timber harvest within the 0.5, 0.7 and 1.3 radii (representing different levels of habitat use by Northern
3595 Spotted Owls) has a potential to impact quality and extent of owl habitat, and consequently, owl fitness.
3596 Timber growth is slow, and consequently, regrowth of owl habitat is slow. Therefore, it is important to
3597 understand the cumulative impact to activity centers over time. As a way of evaluating this impact, the
3598 amount of habitat proposed for harvest was calculated for activity centers that were associated with
3599 THPs utilizing Option (e) and Option (g) submitted in 2013 were selected, and harvest history followed
3600 back in time. Of the 17 activity centers evaluated in the interior, six activity centers have experienced
3601 greater than 2,000 acres timber harvest cumulatively over time within the 1.3 mile radius (~3,400 acres)
3602 home range, and six activity centers have experienced greater than 250 acres timber harvest within the
3603 0.5 mile radius (~500 acres) core range. Of the 14 activity centers evaluated on the coast, six activity
3604 centers experienced harvest of over 500 acres, cumulatively, within the 0.7 mile radius (~985 acres) core
3605 range, with two of these over 1,000 acres (see Table 15, Table 16 and Appendix 3).

3606 Of the interior NTMPs evaluated, 19 (54%) were associated with at least one Northern Spotted Owl
3607 activity center within 1.3 miles of the plan boundary. Of the coastal NTMPs evaluated, 96 (78%) were
3608 associated with at least one activity center within 1.3 miles of the plan boundary. For NTMPs, it was
3609 difficult to assess the extent of harvest and habitat retention because the level of information available,
3610 particularly older plans, was limited in some cases. Considering NTMPs evaluated, we can infer that owl
3611 habitat is retained to some extent; however, we cannot determine the type or quality of habitat
3612 retained. For instance, high quality nesting and roosting habitat may be harvested more frequently,
3613 thereby reducing owl fitness.

3614 Several research studies have demonstrated a link between owl fitness and amount of habitat,
3615 structural characteristics, and spatial configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al.
3616 2005, Irwin et al. 2007) – see the Habitat Effects on Survival and Reproduction and the Habitat Loss and
3617 Degradation sections of this document. Given what we know about owl habitat and fitness, it is
3618 reasonable to believe that high levels of harvest, such as levels documented for some activity centers in
3619 the harvest analysis described above, can negatively impact Northern Spotted Owls. In some of the
3620 activity centers evaluated for harvest history, harvest cumulatively exceeded the guidance provided in
3621 the Forest Practice Rules regarding the amount of habitat retention. Furthermore, by comparing
3622 territory loss on private timber lands to USFS lands from 1978-2007 the USFWS (2009) found a 54%
3623 decline in pair status to no response and a 23% decline from pair status to single owl status on private
3624 timber lands, whereas on USFS lands 80% of the sites did not change pair status. These results suggest
3625 inefficiency in rules guiding timber harvest for the protection of Northern Spotted Owls.

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3626 **Harvest of Hardwood Forests**

Comment [ABF92]: See my General Comment 3 under the THREATS section

3627 The economic value of tree species growing on timberlands differs, with conifers being generally more
3628 valuable than hardwoods. The low value of hardwoods historically discouraged their harvest and
3629 removal from timberlands during commercial harvesting (Merenlender et al 1996). The differential
3630 retention of hardwoods coupled with aggressive growth of tanoak during early successional processes
3631 lead many north coast timberlands to be heavily dominated by hardwoods.

3632 To counter this history, the Forest Practice Rules (CCR 912.7, 932.7, and 952.7) provide timber resource
3633 conservation standards that require that the percentage of site occupancy of Group A (generally
3634 conifers) species to not be reduced relative to Group B species (generally hardwoods) as a result of
3635 harvest. The Forest Practice Rules specifically require retention of trees of each native commercial
3636 species inclusive of Group B hardwoods where present at the time of harvest in a limited number of
3637 silvicultural situations: during the seed step of shelterwood (913.1, 933.1, 953.1 (d)(2)(F)) and seed tree
3638 (913.1, 933.1, 953.1 (c)(1)(F)) silvicultural systems and only when applied in the absence of a Sustained
3639 Yield Plan. The purpose of this retention is to maintain and improve tree species diversity, genetic
3640 material and seed production, and is achieved by requiring the leave trees to be of the best phenotypes
3641 available. These trees need not be retained during the final, removal step. Otherwise, the Forest
3642 Practice Rules relegate hardwood retention during timber harvest to standards developed during plan
3643 development and agency review such as “Maintain functional wildlife habitat in sufficient condition for
3644 continued use by the existing wildlife community within the planning watershed” (CCR 897(b)(B)), and
3645 the “Hardwood Cover” evaluation requirements of the Cumulative Impacts Technical Rule Addendum #2
3646 (CCR 912.9, , 932.9, 952.9 (c)(4)(e).

3647 Outside of the timber harvest regulatory arena, some landowners may be actively suppressing
3648 hardwood competition with the more economically valuable conifers. In these situations, the
3649 Department has no authority to identify or mitigate impacts by recommending retention standards.
3650 Some landowners have developed internal standards that they apply during and outside timber harvest
3651 operations. While these may assure specimens and some level of hardwood function are retained on
3652 timberlands, the Department is unaware of the empirical support for the efficacy of these levels to
3653 provide spotted owl habitat and to support spotted owl forage base.

3654 **Regulatory Mechanisms Considerations**

3655 Changes in nesting and roosting habitat and dispersal habitat assessed for the NWFP have provided an
3656 assessment of broad landscape changes across the range of the Northern Spotted Owl, including
3657 changes specific to physiographic regions within California. As has been demonstrated at territory-based
3658 studies of habitat in California and southern Oregon, Northern Spotted Owl habitat is composed of a
3659 mosaic of mature forests intermixed with younger forest types within the home ranges of individual
3660 owls (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007), with particular
3661 combinations providing high quality habitat. Some of the forest types included in high quality Northern
3662 Spotted Owl home ranges are younger forests, which would have been considered foraging habitat in

Comment [ABF93]: Much of these mature forest include both conifer and hardwood species

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3663 the NWFP modeling, and therefore were not assessed for change in the recent review of the NWFP.
3664 Detection of changes in habitat quality at the smaller scale of Northern Spotted Owl home range
3665 requires an assessment of management practices at this scale, and can be accomplished by evaluating
3666 timber harvest practices around known Northern Spotted Owl activity centers.

3667 For core and home range habitat use, studies have documented a more concentrated and frequent use
3668 of habitat features surrounding the activity center (e.g., Hunter et al. 1995, Bingham and Noon 1997,
3669 Meyer et al. 1998, Zabel et al. 2003, USFWS 2009). In addition, the shape of core area use varies due to
3670 the availability of nesting, roosting and foraging habitat, which deviates from the typical circular
3671 representation or core habitat use. The percent of older forest represented within the home range area
3672 varies from 30-60%, with an average of about 45% (USFWS 2009). For a more detailed discussion on
3673 core and home range use, see Biology and Ecology section of this report.

3674 As discussed in the Habitat Requirements section of this report, certain habitat characteristics have been
3675 shown to support high quality Northern Spotted Owl territories, with both the amount and spatial
3676 configuration of different habitat types at a territory contributing to levels of survival and productivity in
3677 the resident owls. This measure of habitat quality at the scale of Northern Spotted Owl home range has
3678 been termed “habitat fitness potential” (HFP; Franklin et al. 2000). See the Habitat Effects on Survival
3679 and Reproduction section of this report for a discussion of HFP and additional studies that have
3680 contributed to an understanding of habitat characteristics that provide high HFP. The studies that have
3681 evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types
3682 that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent
3683 and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

3684 The definition of take under federal ESA includes actions that would reduce the quality of habitat;
3685 therefore, take avoidance recommendations by the USFWS can provide a reasonable baseline to assess
3686 impacts to habitat quality. Estimation of the likelihood of take according to Section 9 of the ESA would
3687 benefit from a better understanding between habitat quality and owl fitness. When the Forest Practice
3688 Rules were originally created, the criteria for owl habitat and retention were based on the best science
3689 and expert opinion at the time and lacked information on reproduction, survival and occupancy.

3690 The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the
3691 Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls
3692 may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis
3693 conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from
3694 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory
3695 loss. They found on private timber lands there was a 54% decline in pair status to no response, and a
3696 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change
3697 pair status. A lack of owl responses and a lack of suitable habitat to support continued occupancy and
3698 survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early
3699 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat
3700 characteristics to owl fitness, the USFWS asserted that the Forest Practice Rules were insufficient to

Comment [ABF94]: An important consideration is the interactive effects of habitat quality and climate on survival. During poor weather years, owls in poor quality habitat may experience much lower survival than those in high quality habitat (see Figure 11 in Franklin et al. 2000)

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adequately avoid take of Northern Spotted Owls (USFWS 2009), although we are not aware of any legal cases under the current regulatory framework.

To address insufficiencies in the Forest Practice Rules, the USFWS used the results of demography studies (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005) and additional studies on habitat selection by Northern Spotted Owl (e.g., Solis and Gutiérrez 1990, Zabel et al. 1993, Irwin et al. 2007), to develop harvest management guidelines for the interior and coast that would adequately avoid take of Northern Spotted Owl in California (USFWS 2008b). The purpose of the USFWS guidelines was to enable CAL FIRE to more effectively and appropriately evaluate THPs and NTMPs to result in timber harvest activities that do not result in take of owls according to ESA standards. To accompany the guidelines, the USFWS developed a white paper (USFWS 2009) describing the regulatory and scientific basis for developing the criteria within the guidance for the interior region of California. The USFWS did not develop a sister document for the coast region in California. Because criteria in the USFWS 2008 guidelines were developed using the most up to date scientific information for habitat effects on owl fitness within the core and home range areas, the guidelines differ somewhat from the Forest Practice Rules. Criteria noted in the Forest Practice Rules Section 919.9 subdivision (g) and the USFWS 2008 and 2009 guidelines are summarized in Tables 20, 21 and 22 below. Definitions of owl habitat referred to in Forest Practice Rules Section 919.9(g) can be found in Appendix 2.

Among the recommendations in the USFWS guidance to CAL FIRE (USFWS 2008b), minimum amounts of nesting, roosting, and foraging habitat are described for both 0.5 mile (502 acres; interior forests) and 0.7 mile (985 acres; coastal forests) radius surrounding the activity center, representing the core habitat use, and for an outer ring of habitat from 0.5 to 1.3 miles radius (2,908 acres; interior forests) surrounding the activity center, representing broader home range. The USFWS determined that within the interior forests in California, 0.5 mile radius, rather than the 0.7 mile radius noted in the Forest Practice Rules, more effectively captured actual core habitat use of Northern Spotted Owls (USFWS 2009). The 2008 USFWS guidelines also revised the definitions of nesting, roosting, and foraging habitat for the interior, and included differentiation between high quality and low quality habitat (USFWS 2008b and USFWS 2009). Although assumptions were required in order to develop a single set of guidelines for the interior forests, the amount and spatial configuration of habitat to be retained is consistent with what was found in studies that evaluated habitat quality as a function of owl fitness.

When the Northern Spotted Owl guidelines were added to the Forest Practice Rules in 1992, the intent was to protect Northern Spotted Owls and suitable habitat used for nesting, roosting and foraging. Since that time, additional scientific literature (e.g., Franklin et al. 2000, Irwin et al. 2000, Zabel et al. 2003, Courtney et al. 2004, Dugger et al. 2005, Glen et al. 2004, Olson et al. 2004, Irwin et al. 2007) has been published that helps to further elucidate habitat use of Spotted Owls and associations between habitat and owl fitness. It is also known that response and occupancy rates have declined at some historical activity centers. Though the specific reasons why response and occupancy rates have declined are unknown, there are multiple likely factors including cumulative habitat loss and degradation, and presence of Barred Owl. Given this broad range of possibilities, the Forest Practice Rules may not be sufficient at protecting loss of Northern Spotted Owl habitat within its range in California.

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3740 **Table 20.** Criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted
3741 Owls on private timberlands according to Forest Practice Rules Section 919.9(g).

Forest Practice Rules Subsection	Proximity to Activity Center (acreage)	Criteria Description
919.9(g)(1)	Within 500 feet of the activity center (~18 acres)	Characteristics of functional nesting habitat must be retained.
919.9(g)(2)	Within 500-1000 feet of the activity center (1,000 foot radius circle is ~72 acres)	Retain sufficient functional characteristics to support roosting and provide protection from predation and storms.
919.9(g)(3)	Within a 0.7 mile radius of the activity center (~985 acres)	Provide 500 acres of owl habitat. The 500 acres includes the habitat retained in subsections 919.9(g)(1) and (2) and should be as contiguous as possible.
919.9(g)(4)	Within 1.3 miles of each activity center (~3,400 acres)	Provide 1,336 total acres of owl habitat. The 1,336 acres includes the habitat retained within subsections 919.9(g)(1)-(3).
919.9(g)(5)	Shape of habitat retention	Areas established shall be adjusted to conform to natural landscape attributes such as draws and stream courses while retaining the total area required within subsections 919.9(g)(1) and (2).

3742

3743 **Table 21.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of
3744 Northern Spotted Owls on private timberlands, and selected stand structural parameters used to classify
3745 nesting/roosting and foraging habitat for Northern Spotted Owls in the northern coastal region of California
3746 (USFWS 2008b).

Habitat Type	Acre Retention in Core Area (within 0.7 mile; ~985 acres) ¹	Acre Retention in Outer Ring (between 0.7-1.3 mile) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	DBH	Percent Canopy Cover	Basal Area
Nesting/Roosting	200 acres	NA	200 acres	≥ 11 inch	≥ 60%	≥ 100 ft ² /acre
Foraging	≥ 300 acres	NA	≥ 300 acres	≥ 11 inch	≥ 40%	≥ 75 ft ² /acre
Suitable Habitat ²	NA	≥ 836 acres	≥ 836 acres			

3747 ¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the
3748 plan.

3749 ² Suitable Habitat is defined as habitat that meets either Nesting/Roosting or Foraging definitions, or a combination of
3750 Nesting/Roosting and Foraging habitat.

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3751 **Table 22.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted Owls on private timberlands,
3752 and selected stand structural parameters used to classify nesting/roosting and foraging habitat for Northern Spotted Owls in the northern interior region of
3753 California (USFWS 2008b and 2009).

Habitat Type	Within 1,000 feet of Activity Center	Acre Retention in Core Area (within 0.5 mile; ~500 acres) ¹	Acre Retention in Outer Ring (between 0.5-1.3 mile; ~2,900 acres) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	Basal Area Parameter	Quadratic Mean Diameter Parameter	Large trees/acre Parameter	Canopy Closure Parameter
High Quality Nesting/Roosting	No timber operations are allowed other than use of existing roads.	100 acres	NA	100 acres	≥ 210 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Nesting/Roosting		150 acres	NA	150 acres	Mix, ranging from 150 to ≥ 180 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Foraging		100 acres	655 acres	755 acres	Mix, ranging from 120 to ≥ 180 ft ² /acre	≥ 13 inch	≥ 5	≥ 40%
Low-quality Foraging		50 acres	280 acres	330 acres	Mix, ranging from 80 to ≥ 120 ft ² /acre	≥ 11 inch	NA	≥ 40%

¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the plan.

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3756 A comparison of the habitat definitions and retention requirements in Section 919.9(g) of the Forest
3757 Practice Rules (Appendix 2 and Table 20) and the revised take avoidance guidance provided by the
3758 USFWS (2009; summarized in Table 21 and 22) reveals how implementation of the Forest Practice Rules,
3759 as written, may result in degradation of habitat quality around Spotted Owl activity centers in the
3760 interior portion of the range. The definition of functional nesting habitat under the Forest Practice Rules
3761 might be adequate to provide suitable nesting or roosting habitat for spotted owls, although the
3762 average stem diameter is less than that recommended by the USFWS. The functional roosting habitat
3763 under Forest Practice Rules does not meet the requirements of roosting habitat under the USFWS
3764 recommendation; habitat falling under the roosting habitat definition would be considered low-quality
3765 foraging habitat under the USFWS recommendations. Functional foraging habitat as defined under
3766 Forest Practice Rules might meet the requirements for low-quality foraging habitat as defined by
3767 USFWS, but does not meet the requirements of foraging habitat.

3768 Under the Forest Practice Rules minimum retention requirements, stands that meet the USFWS
3769 recommendation for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
3770 The habitat retained within 1,000 feet (~72 acres) would be defined as low-quality foraging habitat in
3771 the USFWS guidance. Because the 500 acres of spotted owl habitat to be retained within 0.7 miles and
3772 the total of 1,336 acres to be retained within 1.3 miles of an activity center can be composed of
3773 functional foraging habitat, there is no requirement in the Forest Practice Rules for the retained habitat
3774 within 0.7 or 1.3 miles of the activity center to include nesting or roosting habitat. Also, using the revised
3775 habitat definitions provided by USFWS (2009), this retained foraging habitat could be of low quality.
3776 Although similar acreage of habitat is retained under the Forest Practice Rules and the USFWS
3777 recommendations, very little of the habitat retained under Forest Practice Rules is required to meet the
3778 requirements of nesting or roosting habitat. Consequently, depending on how the rules are
3779 implemented, management could result in a reduction in habitat quality around Northern Spotted Owl
3780 sites and could lead to declines in survival, productivity, and overall fitness.

3781 **Habitat Loss from Marijuana Cultivation**

3782 Large-scale marijuana cultivation in remote forests throughout California has increased since the mid-
3783 1990s, coinciding the time the “Compassionate Use Act” was passed in 1996 (Proposition 215) that
3784 allows the legal use and growth of marijuana for certain medical purposes (Bauer et al. 2015). Within
3785 the range of the Northern Spotted Owl, Shasta, Tehama, Humboldt, Mendocino, and Trinity counties
3786 comprise the areas known for the most marijuana cultivation in California due to the remote and rugged
3787 nature of the land, making cultivation difficult to detect (National Drug Intelligence Center 2007, Bauer
3788 et al. 2015). Illegal marijuana cultivation grows on public and private land are widespread in California
3789 (Gabriel et al. 2013, Thompson et al. 2013, Office of National Drug Control Policy 2015), and may also
3790 negatively impact owl habitat through degradation and removal, though data on the extent of this
3791 impact is not well known. The Office of National Drug Control Policy (2015) reported that in 2012 3.6
3792 million plants were eradicated from 5,000 illegal outdoor marijuana grow sites in the United States, of
3793 which 43% were removed from public and tribal lands. Additionally, the USFS reported that 83% of the
3794 plants removed were from California (Office of National Drug Control Policy 2015). Areas with higher

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3795 prevalence of marijuana cultivation may also contain high numbers of Northern Spotted Owl activity
3796 centers (see Figure 3), especially in areas where riparian habitat exists.

3797 As discussed previously, for typical timber harvest activities, land owners are bound by the Forest
3798 Practice Rules and would therefore need to submit a THP, Spotted Owl Management Plan, Spotted Owl
3799 Resource Plan or exemption notification to the appropriate governing agencies. However, small scale
3800 timber removal in association with legal marijuana cultivation on private land does not require review or
3801 approval from state or federal governments as long as the timber is not sold. Habitat alteration also
3802 occurs in association with illegal marijuana grow sites, but the extent is not well known due to the
3803 secretive nature of these activities. Therefore, loss of timber and other habitat components important
3804 to Northern Spotted Owls (e.g., riparian habitat alterations) for the cultivation of marijuana for such
3805 purposes is largely unregulated.

3806 To date, there has been no study that analyzes the impact of marijuana cultivation sites on Northern
3807 Spotted Owl habitat or fitness. However, there is a potential for negative impacts of sites placed on
3808 private and public land within the owl’s range. The level of impact would likely depend on density of
3809 cultivation sites in proximity to owl activity centers, and whether sites are placed within suitable owl
3810 habitat.

3811 In an effort to assess potential environmental impacts to aquatic ecosystems from legal marijuana
3812 cultivation, Bauer et al. (2015) delineated cultivation sites (outdoor plantations and greenhouse
3813 locations), using Google Earth satellite imagery from 2011 and 2012, within four watersheds (hereafter
3814 referred to as the study area): Upper Redwood Creek, Redwood Creek South, and Salmon Creek, located
3815 in Humboldt County; and Outlet Creek, located in Mendocino County. In addition to the Bauer et al.
3816 (2015) study area, cultivation sites in the Mad River Creek watershed, in Mendocino and Trinity
3817 counties, were also delineated due to interest in identifying potential impacts to aquatic species and
3818 water quality in that area. Cumulatively, these 5 watersheds represent approximately 4% of the
3819 Northern Spotted Owl range in California (Table 23). Within these watersheds, marijuana cultivation
3820 sites varied in size from 0.002 to 2.9 acres and comprised a total of 362 acres. This is a relatively small
3821 portion of the watersheds assessed.

3822 **Table 23.** The number of marijuana cultivation sites within each watershed, and area (acres) associated with each.
3823 Watersheds assessed are within Humboldt, Mendocino, and Trinity counties.

Watershed Name	Area (acres)	No. of Cultivation Sites	Total area (acres) of Cultivation Sites
Upper Redwood Creek	155,338	253	43
Redwood Creek South	16,653	369	53
Salmon Creek	23,489	515	42
Outlet Creek	103,554	795	90
Mad River Creek	321,972	416	134

3824

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To assess potential impacts to Northern Spotted Owls we assessed marijuana cultivation locations from 2011 and 2012 within the watersheds mentioned in Table 23, together with owl activity centers locations (Figure 19). We found that no activity centers were within delineated cultivation sites; however, 10 activity centers are within 0.5 miles of the cultivation sites, and 96 within 1.3 miles. Depending on the size of the site and how much suitable owl habitat is removed, impacts to owls may vary. The amount and type of owl habitat removed is summarized in Table 24. For the cultivation sites delineated in 2011 and 2012, much of the habitat removed was unsuitable for Northern Spotted Owls, with the exception of Mad River Creek watershed; here, 12.45 acres of highly suitable, 6.89 acres of suitable, and 22.91 acres of marginal owl habitat was removed.

Table 24. Level of owl habitat removed in each watershed.

Watershed Name	Highly Suitable	Suitable	Marginal	Unsuitable
Upper Redwood Creek	2.67	3.56	22.91	8.9
Redwood Creek South	1.11	1.33	14.90	32.47
Salmon Creek	0.00	0.89	12.23	20.68
Outlet Creek	3.56	5.56	15.35	38.25
Mad River Creek	12.45	6.89	22.91	8.90

As described elsewhere in this report, habitat removal, fragmentation, and degradation can all have varying degrees of negative impacts on spotted owls depending on how much suitable habitat is removed within their core range (e.g., represented by the 0.5 mile buffer surrounding the activity center) and within their home range (e.g., represented by the 1.3 mile buffer surrounding the activity center). Of the 362 acres of forestland or riparian habitat removed for marijuana cultivation, approximately 20 acres are within highly suitable Northern Spotted Owl habitat, 18 acres are in suitable habitat, and 97 acres are in marginal habitat. As an example of potential impacts to Northern Spotted Owl activity centers, Figure 20 shows a zoomed in area in Humboldt County where marijuana cultivation sites overlap the home range for several activity centers. One activity center displayed in Figure 20 experienced removal of 4.45 acres of highly suitable habitat, 0.67 acres of suitable, 4.45 acres of marginal, and 0.89 acres of unsuitable habitat within the 1.3 mile buffer.

The data used for this analysis comes with certain limitations when assessing long-term impacts to the Northern Spotted Owl. First, the dataset is a snapshot in time during 2011 and 2012 and does not represent expansion of cultivation sites since the data were collected. The data also only covers 4% of the Northern Spotted Owl range and therefore is only representing a small area of potential impact. Marijuana cultivation is occurring outside of the area assessed. To more fully consider impacts a similar analysis would have to be done within the entire range. In addition, smaller clearings (less than 10 mi²) are likely not captured in the dataset due to difficulties identifying and delineating smaller sites using aerial imagery and not all sites locations are reported as required by law. Sites likely have not been captured for other reasons as well; for example, some sites are intentionally placed in areas where they are harder to detect (e.g., sites with higher canopy closure). Law enforcement efforts and ground truthing helped fill in the gaps for the data collected in 2011 and 2012, but it is still uncertain how many

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3858 sites were not accounted for. Lastly, there may be other activities associated with the cultivation sites
3859 not captured using this data that can also have an impact in owl, such as placement of roads and
3860 vehicular traffic.

3861 Given above uncertainties regarding the dataset used in this analysis, it is plausible to assume that the
3862 density of cultivation sites is likely higher than represented in the dataset. In addition, given the density
3863 of cultivation sites within Humboldt, Trinity and Mendocino counties represented in this analysis, and
3864 the fact that the watersheds analyzed comprise only 4% of the Northern Spotted Owl range, it is also
3865 very plausible to assume that marijuana cultivation sites are impacting spotted owl habitat, thereby
3866 likely impacting fitness to some extent.

3867 **Wildfire**

3868 Effect of Wildfire and Salvage Logging

Comment [ABF95]: See my General Comment 4 under the THREATS section

3869 Wildfire is a natural process in California's forests, and in much of its range the Northern Spotted Owl
3870 has evolved in a landscape of frequent wildfire. Despite this, fire is often considered a primary threat to
3871 Northern Spotted Owl habitat due the owl's preference for older forests and the capacity of fire to
3872 rapidly remove or degrade habitat. The mature forests preferred by owls for nesting and roosting can
3873 take decades to centuries to develop following removal, depending on location and forest type and fire
3874 severity. The USFWS revised recovery plan (USFWS 2011) considered fire to be a primary threat to the
3875 Northern Spotted Owl, along with ongoing losses to timber harvest and competition with the Barred
3876 Owl. As discussed above, fire has become the primary cause of nesting and roosting habitat loss on
3877 federal lands since implementation of the NWFP, only surpassed by rangewide losses due to timber
3878 harvest, which have been concentrated on nonfederal land (Davis et al. 2011).

3879 The majority of the natural disturbance loss (e.g., disease, insects, wildfires) of nesting and roosting
3880 habitat on federal lands since 1994 has occurred in the five relatively dry physiographic provinces
3881 (eastern Washington, eastern Oregon, and California Cascades; Oregon and California Klamath; Figure
3882 21), with about 86% (211,300 acres) of the natural disturbance loss occurring in these provinces (Davis
3883 et al. 2011).

3884 These dry provinces contain only about 42% of the total nesting and roosting habitat acreage on federal
3885 lands rangewide. Most habitat loss in the dry provinces was due to wildfire in the Oregon and California
3886 Klamath and the eastern Washington and eastern Oregon Cascades (Davis et al. 2011). Degradation of
3887 nesting and roosting habitat from fire was also estimated, with most degradation occurring in the
3888 western Cascades (Davis et al. 2011).

3889 Research on the effect of wildfire on Spotted Owl habitat use and selection, occupancy, and survival has
3890 been conducted throughout the range of the species from eastern Washington and southern Oregon, in
3891 the Sierra Nevada mountains in the range of the California Spotted Owl, and in Arizona and New Mexico
3892 in the range of the Mexican Spotted Owl (e.g., Gaines et al. 1997, Bond et al. 2002, Jenness et al. 2004,
3893 Bond et al. 2009, Clark et al. 2011, 2013). Studies to date are scattered throughout the range of the

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3894 Spotted Owl and have generally been performed opportunistically due to the difficulties associated with
3895 experimental fire research in a natural setting; much uncertainty remains on the effect of wildfires on
3896 the extent and quality of Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates
3897 by Spotted Owls have been somewhat equivocal, in some cases showing that stand replacing wildfire
3898 has a negative impact on occupancy (e.g., Gaines et al. 1997), and in other cases showing no adverse
3899 impact of wildfire on Spotted Owl occupancy (e.g., Jenness et al. 2004). Here we focus on the relatively
3900 extensive studies from the Sierra Nevada Mountains in the range of the California Spotted Owl and from
3901 southwestern Oregon in the range of the Northern Spotted Owl, as these areas more closely represent
3902 the forest types within the interior range of the Northern Spotted Owl in California and are relatively
3903 well studied.

3904 In the southern Sierra Nevada, in areas with a mosaic of burned and unburned forests, California
3905 Spotted Owls have been shown to use forests that have experienced a full range of burn severities. Bond
3906 et al. (2009) found the degree to which a post-fire site was used varied with burn severity and with the
3907 function of the site in meeting various life history requirements (i.e., nesting, roosting, or foraging). This
3908 study occurred in an area that experienced the full range of burn severities, resulting in owl territories
3909 with a mosaic of all burn classes, ranging from unburned forests to areas with most of the overstory
3910 removed by fire (high-severity burn areas were defined as those resulting in high to complete mortality
3911 of dominant vegetation; low-severity burn areas were defined as those with little change in cover and
3912 little tree mortality; moderate-severity burn areas were those between high- and low-severity, with a
3913 mixture of effects on vegetation). Most California Spotted Owl roost sites (85%) occurred in unburned
3914 and low-severity burn areas, and owls avoided roosting in moderately and severely burned areas.
3915 Conversely, California Spotted Owls selected foraging sites represented by all severities of burned forest
3916 and avoided unburned forest (Bond et al. 2009). This study illustrated that California Spotted Owls use
3917 multiple forest types within a home range to meet nesting, roosting, and foraging needs, and that
3918 moderate to high severity fires may impact preferred nesting and roosting habitat while providing
3919 foraging habitat. In contrast to the findings of Bond et al. (2009), recent work on the impact of fire on
3920 foraging site selection by California Spotted Owls in Yosemite National Park showed that owls selected
3921 for areas of low-severity burns but avoided areas of high-severity burns (Eyes 2014). The owls that were
3922 tracked in the burned areas of the southern Sierra Nevada (Bond et al. 2009) were shown to have a diet
3923 composed of predominately pocket gophers (Bond et al. 2013), whereas the diet of California Spotted
3924 Owls in unburned forests was dominated by woodrats and northern flying squirrels, depending on
3925 location. Breeding home range sizes were similar for owls occupying burned and unburned areas (Bond
3926 et al. 2013). The apparent shift to an alternative prey source in the post-fire landscape of the Sierra
3927 Nevada may have allowed California Spotted Owls to effectively utilize high-severity burn areas and to
3928 maintain similar home range sizes.

3929 The use of a diverse forest composition in the Sierra Nevada is consistent with research conducted in
3930 the range of the Northern Spotted Owl that indicate high quality habitat is composed of older more
3931 mature forest among a mosaic of other forest types (Franklin et al. 2000, Olson et al. 2004). California
3932 Spotted Owls in the Sierra Nevada also selected for foraging sites that included edge between burned
3933 and unburned forests and between burn areas of different severity classes (Bond et al. 2009). This is

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3934 consistent with the above studies on Northern Spotted Owls which showed high quality habitat to have
3935 high amounts of edge between old forests and other forest types.

3936 In a study of post-fire occupancy at six fire sites across the range of the California Spotted Owl in the
3937 Sierra Nevada, Lee et al. (2012) found no difference in occupancy rates between burned and unburned
3938 sites. As with the above study on post-fire habitat selection, this study included fires with a range of
3939 burn severities, which is typical of fires in the Sierra Nevada (Odion and Hanson 2006). Of the six fires
3940 included in the study, on average 32% of the burned area was burned at high-severity so these results
3941 are applicable to mixed-severity fires that result in a mosaic of post-fire conditions. A subset of burned
3942 sites included in the study (9 of 41) burned at higher severity (>50% high severity burn of suitable owl
3943 habitat). Owls were detected at five of these nine sites post-fire (Lee et al. 2012), suggesting that sites
3944 that were exposed to higher amounts of high-severity fire might have experienced reductions in
3945 occupancy, but this was not modeled. Salvage logging of timber after a fire was known to occur on eight
3946 burned sites post-fire. California Spotted Owls initially occupied seven of the eight sites after the fire,
3947 but following the salvage logging none of the sites remained occupied. Post-fire logging may have
3948 adversely affected occupancy of burned sites but the sample size was too small for the effect to be
3949 modeled (Lee et al. 2012). An additional study in the Sierra Nevada compared occupancy rates at 10
3950 unburned sites to 9 sites that burned at low to moderate severity in Yosemite National Park and found
3951 no difference in occupancy rates between burned and unburned sites (Roberts et al. 2011). The study
3952 area was restricted to areas with $\geq 40\%$ canopy cover, and occupancy was positively correlated with total
3953 tree basal area and canopy closure (Roberts et al. 2011). This study did not address effects of high-
3954 severity fire, nor post-fire logging.

3955 In the range of the Northern Spotted Owl, the most extensive evaluation of the effect of fire on owls has
3956 been conducted on a group of three fires in the Klamath and Western Cascades physiographic provinces
3957 of southwest Oregon (Clark 2007, Clark et al. 2011, 2013). By tracking radio-marked owls with territories
3958 inside and adjacent to burned areas, Clark et al. (2011) were able to estimate the effects of fire on
3959 occupancy and survival of Northern Spotted Owls. The occurrence of a demographic study area (South
3960 Cascades) in proximity to the fires allowed for comparison of unburned areas to pre- and post- fire rates
3961 within the fire footprints. On one of the fire study areas (Timbered Rock fire), 22 territories had been
3962 surveyed for ten years pre-fire and so allowed for a comparison of pre- and post- fire occupancy.
3963 Occupancy at this site was compared to the nearby South Cascades study area and the two areas were
3964 shown to have similar trends in occupancy rates prior to the Timbered Rock fire in 2002. However,
3965 extinction rates in the Timbered Rock fire area increased after the fire, resulting in declines in occupancy
3966 (Clark 2007, Clark et al. 2013). Only 20% of territories at the Timbered Rock fire were occupied by a pair
3967 of owls by the end of the study period in 2006 (four years post fire), where >50% of territories had been
3968 occupied in all years pre-fire. These declines were not observed at the unburned South Cascades study
3969 area. Data collected at all three fires from 2003-2006 was used to model post-fire rates and suggested
3970 that high extinction rates and low colonization rates led to declines in post-fire occupancy (Clark 2007).

3971 On two of the burned areas in southwest Oregon (Timbered Rock and Quartz fires), 23 radio-marked
3972 Northern Spotted Owls were tracked over a one year period in order to estimate survival rates of owls
3973 within and adjacent to burns. Mean annual survival rates of owls displaced by wildfire (0.66 ± 0.14) or

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3974 occupying territories within the burned area (0.69 ± 0.12) were lower than those for owls outside of
3975 burned areas (0.85 ± 0.06) (Clark et al. 2011). Survival rates of owls outside of burned areas were similar
3976 to rates at the nearby unburned demographic study area (South Cascades; 0.85 ± 0.01) (Anthony et al.
3977 2006). The two fires included in the survival study each burned about 50% of the owl habitat at mixed
3978 severities from low to high, which is comparable to fires included in studies on California Spotted Owl in
3979 the Sierra Nevada. Of the 24 owls tracked, 5 died during the study. Necropsies were performed on 4 of
3980 these owls and showed that all were severely emaciated and likely died due to starvation (Clark et al.
3981 2011). This, and the fact that owls in the study maintained larger home ranges post-fire (Clark 2007),
3982 suggest that food limitation might have played a role in reduced survival rates. Also, the documented
3983 dispersal of several adult Northern Spotted Owls out of the burn area at the Timbered Rock fire 1-2
3984 years post-fire suggests that insufficient habitat remained at abandoned territories to support an owl
3985 pair (Clark et al. 2013). Both of the fire areas in this study were salvaged logged post-fire, with about
3986 20% of the area logged in each fire. See discussion on potential effects of salvage logging below.

3987 Using the telemetry data collected by Clark in southwest Oregon, Comfort (2013) evaluated selection of
3988 habitats relative to availability following mixed-severity fire disturbance. The strongest predictor of
3989 spotted owl presence was habitat suitability (as defined in the 10-year review of the Northwest Forest
3990 Plan (Davis and Lint 2005)). Northern Spotted Owls avoided large, contiguous patches of high-severity
3991 disturbance and preferentially used areas of lower severity disturbance (Comfort 2013). At small spatial
3992 scales (<0.8 ha), Spotted Owls did select for areas with hard edge created by high severity fire, but at
3993 larger spatial scales, hard edges were avoided. This suggests that at the scale of a home range, owls
3994 selected for large patches of contiguous high suitability habitat interspersed with small patches (<0.8 ha)
3995 of high severity fire or salvage logging (Comfort 2013). Because salvage logging occurred in the study
3996 area on private industry land, the analysis by Comfort did not distinguish between areas of high-severity
3997 burns and those that were salvage logged, but instead used the combined disturbance of fire and
3998 logging to evaluate owl use of different components of the landscape.

3999 An earlier study evaluated short term survival of Spotted Owls following wildfire by tracking color-
4000 banded owls which occurred on territories that later burned in a wildfire during a period from 1985-
4001 2001 (Bond et al. 2002). Because of the opportunistic nature of observations for this study, only 11
4002 territories were included in the study and they were distributed across the range of the species from
4003 California, Arizona, and New Mexico, and represented all three subspecies of the Spotted Owl. Twenty-
4004 one color-banded owls had occurred on the eleven territories pre-fire and 18 were resighted the year
4005 following fire (Bond et al. 2002). This represents a simple annual survival estimate of 86%, which is
4006 similar to reported estimates of survival in unburned areas. The short-term covered by the study (one
4007 year post-fire) and the small sample size limit the utility of the study in extrapolating to a general effect
4008 of fire on Northern Spotted Owls (of which four territories were included), but they do at least
4009 demonstrate that some wildfires have little short-term impact on Spotted Owl survival. Most territories
4010 in this study burned at low to moderate severity and no salvage logging had occurred between time of
4011 fire and the following year when resighting attempts occurred (Bond et al. 2002).

4012 Post-fire declines in occupancy in southern Oregon contrast with most results for the California Spotted
4013 Owl in the Sierra Nevada. As mentioned above, two of three burn areas in southern Oregon underwent

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fairly extensive salvage logging post-fire. The studies conducted in the Sierra Nevada included some sites that were salvage logged, but sample sizes were too small to model the perceived effect of logging on occupancy. Several authors have suggested that salvage logging after a fire or occurrence of extensive high severity burns likely have contributed to a decline in habitat use, occupancy, or survival of Northern Spotted Owls (Bond et al. 2009, Roberts et al. 2011, Clark et al. 2011, 2013, Lee et al. 2012). With the exception of low severity burns, burned areas have generally not supported nesting habitat but have been shown in some cases to create foraging habitat. The presence of snags has been suggested as an important component of prey habitat and as perch sites for foraging Spotted Owls. We do not know of any research conducted on Northern Spotted Owl prey abundance in burned vs. unburned forests, but early successional forests have been shown to support abundant woodrat populations in the southern portion of the range (see discussion of prey in Life History section) and so burned areas may provide high quality prey habitat once vegetation regrowth produces an understory. Bond et al. (2009) concluded that the most likely explanation for high probability of use by foraging California Spotted Owls of forest patches that experienced high severity burns was increased prey promulgated by enhanced habitat conditions, including increased shrub and herbaceous cover and number of snags, and provided the following discussion on the importance of snags to Spotted Owl prey:

“Snags provide shelters for prey species like woodrats and flying squirrels. In the southern Sierra Nevada, dusky-footed woodrat nests are common where shrubs encircle rock outcrops or snags (Lawrence 1966). Bushy-tailed woodrat (*N. cinerea*) densities in dry forests of eastern Washington, USA, were strongly correlated with arboreal and terrestrial cover in the form of large snags, mistletoe, and large soft logs (Lehmkuhl et al. 2006). Northern flying squirrel population densities in Oregon, USA, were correlated with the occurrence of suitable nesting cavities in trees and early decay-stage snags with diameters >50 cm (Volz 1986).”

Lee et al. (2012) argued that snags play an important role in suitable California Spotted Owl habitat in burned areas. This was based on observations that occupancy decreased when ≥ 20 ha of mature conifer forest was logged within a 400-ha circle surrounding a California Spotted Owl site (Seamans and Gutiérrez 2007), whereas when an average of 32% of suitable habitat within a 400-ha circle burned at high severity no negative effect on occupancy is observed. In southern Oregon, Clark et al. (2013) modeled the effects of fire severity, salvage logging, and pre-fire habitat characteristics on occupancy by Northern Spotted Owls. They found that extinction probabilities increased as the combined area of pre-fire harvest, high-severity burn, or salvage logging increased, resulting in reduced occupancy of nesting territories by Northern Spotted Owls; however, they were unable to distinguish the effect of salvage logging from the other effects (i.e. these factors collectively contributed to declines in occupancy). Observational studies and occupancy modeling conducted to date suggest that post-fire landscapes that are salvage logged experience declines in Spotted Owl occupancy. However, other factors such as initial habitat conditions (e.g., area of pre-fire harvest), the amount and distribution of high-severity fire, regional differences in forest composition and fire history, and differential subspecies response may also influence occupancy. Based on results to date that suggest an impact of salvage logging, Bond et al. (2009) recommended that burned forests within 1.5 km of nests or roosts of California Spotted Owls not

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be salvage logged and Clark et al. recommended restricting salvage logging after fires within 2.2 km of Spotted Owl territories in the range of the Northern Spotted Owl in southern Oregon.

Fire Regime in the Northern Spotted Owl Range

When the USFWS subdivided the range of the Northern Spotted Owl into 12 physiographic provinces, information on fire disturbance regimes was used to inform boundaries (USFWS 1992). Efforts to map the fire-prone portion of the Northern Spotted Owl range since then have generally followed physiographic province boundaries, with the drier provinces of the eastern and California cascades and the Oregon and California Klamath provinces generally considered more fire-prone (e.g., see Rapp 2005, Spies et al. 2006, and Healey et al. 2008). As part of an evaluation of the NWFP, a recent effort to model fire-prone areas used fire history and environmental predictor variables to map the likelihood of large wildfire occurrence throughout the range (Davis et al. 2011). Although this approach did not use existing physiographic province boundaries or other lines used to delineate fire-regimes across the Northern Spotted Owl range to inform the model, results are generally similar to previous descriptions based on broad geographic regions (Figure 22(a)). See Davis et al. (2011) for discussion and potential explanation of differences between model results and previous predictions of fire-prone regions in the eastern and western Oregon Cascades.

Regardless of methodology used, all attempts to map fire-prone areas consistently include large portions of the Northern Spotted Owl range in California, with much of the California Klamath and California Cascades highly prone to fire disturbance. By overlaying the modeling results for fire-prone areas with the Northern Spotted Owl habitat suitability map, Davis et al. (2011) showed that the physiographic province with the most owl nesting and roosting habitat in fire-prone landscapes is the California Klamath Province. This is evident when looking at actual fire history from 1950 to 2013 (Figure 22(b)). Over the last several decades, large acreage fires have been prevalent on the landscape within the Klamath Province.

Within the fire-prone regions of California, fire regimes vary depending on a number of factors, with broad differences noted between the mixed conifer/mixed hardwood forests characteristic of the Klamath Province and the ponderosa pine forests that dominate some portions of the Cascade Province and eastern Klamath Province. The following discussion of historical and current fire regimes in California focuses on these two provinces, as these are the two regions where fire is most likely to have an impact on the Northern Spotted Owl.

Historical Fire Regime in the Klamath Province

As described in the Habitat section of this report, the Klamath Province is an area with extremely high floristic diversity and heterogeneity. This diversity arises from complex patterns in topography, soils, and climate throughout the region, which results in complex vegetation and contributes to a diverse fire regime. The natural fire regime acts in a positive feedback manner to contribute to vegetation heterogeneity and diversity (Odion et al. 2004, Skinner et al. 2006). The dominant conifer species across most of the low and mid-elevations in the Klamath Province is the Douglas-fir, and depending on local

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conditions a wide variety of conifer species may co-occur with this dominant species. At higher elevations, the dominant conifer grades into white fir, and at the highest elevations, a diverse set of subalpine conifer species can occur. Low and mid elevations are characterized by an equally diverse set of hardwood species that form lower canopy layers of mixed conifer hardwood forests and can also occur as pure stands. This occurrence of diverse hardwoods in coniferous forests of the Klamath region may reduce fire severity, and following fire may lead to more rapid recovery by sprouting (Odion et al. 2004, Spies et al. 2006). In drier eastern portions of the Klamath Province, ponderosa pine can be the dominant or co-dominant conifer. Because of the greater extent of ponderosa pine-dominated forests in the California Cascade Province, this forest type is discussed below.

Throughout the Klamath Mountains in the presettlement period most forest stands experienced at least several fires each century, suggesting a mixed fire regime of frequent low- to moderate-intensity fires (Skinner et al. 2006), with low-severity fire composing the largest portion of burned area, and high-severity fire the smallest portion (Agee 1993). Low-severity fire has been defined as those which kill less than 20% of the basal area; high-severity fire causes high tree mortality, with mortality of 70% and above used to define high-severity burns (Agee 1993, Hessburg et al. 2005). Under stable atmospheric conditions, current fires tend to follow a mixed fire regime similar to historical patterns (Taylor and Skinner 1998, Odion et al. 2004). Variation within the mixed-severity fires of the Klamath region has been strongly influenced by topography in both the presettlement and contemporary periods (Taylor and Skinner 1998). As described by Skinner et al. (2006),

“Generally, the upper third of slopes and the ridgetops, especially on south- and west-facing aspects, experience the highest proportion of high-severity burn...The lower third of slopes and north- and east-facing aspects experience mainly low-severity fires. Thus, more extensive stands of multi-aged conifers with higher densities of old trees are found in these lower slope positions. Middle slope positions are intermediate between lower and upper slopes in severity pattern.”

This topographically-controlled fire regime is the most widespread regime in the Klamath Mountains and is controlled by greater heating and drying on certain portions of mountain slopes and climatic variables in deep canyons (Skinner et al. 2006). Temperature inversions that often occur while fires are burning enhance this topographic pattern of fire intensity (Skinner et al. 2006). Historical fires were patchy and relatively small, although fires of up to several thousand acres were relatively common, and the majority of burned areas experienced low and moderate severity fire (Spies et al. 2006). The frequent occurrence of mixed-severity fires created a diverse landscape of older forest with variable openings of younger forest and nonforested areas, with the relative composition of these forest types varying depending on slope position.

Historical Fire Regime in the Cascades Province

South of the latitude of Mt. Shasta in the California Cascades, the vegetation composition and species dominance of lower and mid-montane forests is similar to that in the northern Sierra Nevada, and upper montane forests are more similar to the Klamath Mountains (Skinner and Taylor 2006). Conifer forests dominate the mid-montane zone on both sides of the Cascade Range and are intermixed with

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4130 woodlands and shrublands. On the west side of the Cascades, mixed-species conifer forests dominate
4131 with any of six conifer species co-occurring or sharing dominance (Skinner and Taylor 2006). A
4132 subcanopy of mixed hardwoods may occur beneath the conifer canopy. Extensive areas on the east side
4133 of the Cascade Range are dominated by either ponderosa pine or Jeffrey pine (collectively referred to as
4134 yellow pine; Skinner and Taylor 2006). These forests are less complex than those on the west side with
4135 fewer co-occurring species of conifer and with relatively poor-developed understory historically.
4136 Accordingly, yellow pine-dominated forests had a distinct, more uniform fire regime.

4137 Forest species composition and structure in the different portions of the Cascades Province is related to
4138 fire regime, with areas of mixed-severity fire regimes that occur in the Klamath and portions of the
4139 Cascades frequently supporting multi-storied old growth and the drier forests further east (dominated
4140 by yellow pine) experiencing more frequent, low-severity burns and decreased diversity (Spies et al.
4141 2006). As in the Klamath Mountains, fire-severity in the California Cascades is associated with
4142 topographic position with the high-severity portion of burns more likely to occur on upper slopes and
4143 the low-severity burns occurring predominately on lower slopes. This pattern is less pronounced in the
4144 Cascades than in the more extreme terrain of the Klamath Mountains (Skinner and Taylor 2006). As in
4145 the Klamath region, in regions of the Cascades where fire regime is influenced by topography multi-aged
4146 and multi-sized forests are concentrated on the lower slopes and more even-aged stands that develop
4147 after high-severity burns mostly occurred on upper slopes (Skinner and Taylor 2006).

4148 The portion of the Northern Spotted Owl range which is dominated by ponderosa pine is relatively
4149 uncommon and is distributed in a narrow band on the east side of the Cascades and in limited areas in
4150 southwestern Oregon and northern California (Spies et al. 2006). Jeffrey-pine-dominated forests occupy
4151 the lower elevations on south-, east-, and west-facing slopes in eastside environments (Skinner and
4152 Taylor 2006). These forests occur in the driest portions of the northern spotted owl range. Ponderosa
4153 and Jeffrey pine dominated forests have a distinctly different structure and historical fire regime in
4154 comparison to the mixed conifer forests of the rest of the Klamath and Cascade provinces. Historically,
4155 frequent low-severity burns resulted in low and variable tree densities, with low, patchy developed
4156 understory, and reduced fuel loads (Hessburg et al. 2005). Frequent burns favored fire-tolerant tree
4157 species such as ponderosa pine and maintained fire-tolerant forests by elevating tree crowns and
4158 consuming many small and medium sized trees (Hessburg et al. 2005). The forest structure and
4159 composition in these yellow pine forests that resulted from frequent fires reinforced the occurrence of
4160 low-severity fires by limiting the conditions that could support high severity fires (Hessburg et al. 2005).
4161 Historical open yellow pine forests would not have provided all necessary habitat conditions for the
4162 Northern Spotted Owl, but local areas of high density and complex structure likely provided
4163 requirements for nesting and roosting (Davis et al. 2011) among a landscape of mixed forest types and
4164 nonforest areas.

4165 Recent Changes in Fire Regimes and Possible Causes

4166
4167 Multiple potential causes have been implicated in increasing fire activity over the last several decades.
4168 The success of fire suppression and exclusion has indirectly advanced secondary succession in forests
4169 and changed forest composition by increasing tree density, decreasing prevalence of fire-tolerant tree

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4170 species (e.g., ponderosa pine and Jeffrey pine), and contributing to homogenization of forest structure.
4171 In some cases, timber harvest has directly advanced secondary succession through the selective removal
4172 of the largest trees (Hessburg et al. 2005). Post-harvest tree plantations have created homogeneous
4173 forests dominated by even-aged, smaller-diameter trees that in some cases are less resistance to fire. In
4174 addition, climate variables, including temperature and precipitation, have produced conditions that
4175 promote increased amounts of fire activity.

4176 Beginning in the early 1900s in accessible areas and in the mid-1900s in remote areas, fire suppression
4177 caused a dramatic decline in fire occurrence in the Klamath province (Skinner et al. 2006). The result was
4178 a series of decades, beginning in the early 1900s, with dramatically reduced fire extent over most of the
4179 Klamath region (Taylor and Skinner 1998, 2003; see Figure 23 for example). During this period the fire
4180 rotation (time required to burn an area equal to a defined area of the landscape) increased to an
4181 estimated 974 years in the early 1980s (Miller et al. 2012) compared to a historical estimate for fire
4182 rotation of only 20 years (Taylor and Skinner 2003). In the Cascade Province the fire suppression period
4183 began in the early 1900s. The gentler slopes of the Cascade Province, relative to the Klamath region,
4184 lead to successful fire suppression efforts. This success resulted in a dramatic change in fire frequency
4185 from high frequency low-severity fires to a period of minimal fire occurrence in the California Cascades.

4186 Following several decades of reduced extent and frequency of fire as a result of fire suppression efforts,
4187 the average fire size has increased in recent decades (beginning in the 1980s) across the western United
4188 States (Schwind 2008, Westerling et al. 2006), including the area comprising the Northern Spotted Owl
4189 range in California (Odion et al. 2004, Miller et al. 2012). The area burned annually within the entire
4190 range of the Northern Spotted Owl (Davis et al. 2011) and within the California portion of the range
4191 (Miller et al. 2012) also increased dramatically during this time and the regional fire rotation fell to 95
4192 years by 2008 (from a high of 974 years in the early 1980s). As noted in Figure 24, the years between
4193 1970 and 2009 with the most area burned per year in the California portion of the Northern Spotted Owl
4194 range have all occurred since 1987 (Davis et al. 2011, Miller et al. 2012). Mixed-species forests on the
4195 west side of the California Cascades have changed with the success of fire suppression, with forest
4196 density increasing and species composition shifting toward fire-sensitive white fir (Norman and Taylor
4197 2002, Skinner and Taylor 2006). Although the Cascades portion of the Northern Spotted Owl range in
4198 California has not experienced the number or extent of uncharacteristically large fires that have
4199 occurred in the Klamath province, in recent years several large fires have burned in the eastern Cascades
4200 of Oregon and Washington and in the southern portion of the California Cascades. The gentler
4201 topography of the Cascades is more conducive to extensive fires than the Klamath region (Norman and
4202 Taylor 2003, Skinner and Taylor 2006); where forests have developed high densities of young trees due
4203 to fire suppression, fires that escape fire suppression efforts can become large and burn at high-severity
4204 (Skinner and Taylor 2006).

4205 Although there is evidence that the increase in fire size in recent years has corresponded with an
4206 increase in fire severity in the western U.S., including the Sierra Nevada (Hessburg et al. 2005, Schwind
4207 2008, Miller et al. 2009), trends in burn severity have been less conclusive than trends in fire size and
4208 total area burned (Schwind 2008). There is evidence from both the Klamath and Cascade provinces of
4209 California that the proportion of fire-severities in recent mixed-severity fires has been consistent with

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4210 historical patterns, or that change has only been evident in most recent years (Odion et al. 2004, Hanson
4211 et al. 2009, Miller et al. 2012).

4212 Some researchers have challenged the common perception that fire suppression and fuel build-up is the
4213 main cause of increased fire activity. In their study of large fires in the Klamath Mountains, Odion et al.
4214 (2004) evaluated fire history from 1977 to 2002 and concluded that fuel build-up in the absence of fire
4215 did not occur, and instead fuel that is receptive to combustion may decrease in the long absence of fire
4216 in the study area. These authors also evaluated patterns of burn severity in a nearly 100,000-ha fire that
4217 burned in the Klamath Mountains in 1987 to test the effect of fire history, past timber management, and
4218 vegetation structure on the extent and severity of current fire. Odion et al. (2004) found that multi-
4219 aged, closed forests generally burned at low severity, even where fire suppression efforts had limited
4220 fires over the previous decades. The same study found that areas with a history of high-severity fire and
4221 areas with large amounts of even-aged tree plantations experienced elevated amounts of high-severity
4222 fire. These findings are counter to the common assumption that increased extent of high density forests
4223 will lead to increased occurrence of high-severity fire. The additional findings suggests that the historical
4224 pattern of mixed-fire regime in the Klamath continues to drive patterns of at least some contemporary
4225 fires and can act to maintain diverse, heterogeneous forests (Odion et al. 2004).

4226 Miller et al. (2012) conducted a broad assessment of patterns in the extent of high-severity fire in four
4227 national forests of northwestern California. Their study covered all fires larger than 100 acres during the
4228 years 1910 to 2008 in a 5.8 million acre area including the northern California Coast Range and the
4229 Klamath Mountains, as well as a portion of the southern Cascade Range. This study area covers most of
4230 the range of the Northern Spotted Owl on federal land in California. Although the authors observed
4231 significant increases in both fire size and total annual area burned from 1910 to 2008, they found no
4232 temporal trend in the percentage of high-severity fire in recent years.

4233 Despite the findings of Odion et al. (2004) and Miller et al. (2012), at least one recent fire, the Biscuit
4234 Fire of 2002, has occurred in the Klamath province that was not only large but was of uncharacteristic
4235 high-severity (Skinner et al. 2006). The Biscuit Fire burned about 500,000 acres in southern Oregon and
4236 northern California. Almost 224,000 acres (49%) burned at high severity, with 75-100% canopy tree
4237 mortality, and an additional 14% of the burn area experienced 50-75% mortality (USFS 2003). This large,
4238 relatively high-severity burn was inconsistent with historical burn patterns and was associated with
4239 weather conditions that are conducive to fire (i.e., high winds and low humidity). Conversely, in the
4240 years when the most area has burned in the Klamath province of California since the 1980s, fires have
4241 primarily been caused by region-wide lightning events that strain fire suppression resources and that are
4242 associated with more moderate meteorological conditions. Overall fire severities were relatively low in
4243 these years due to the long duration of fires, weather conditions, and strong inversion events (Miller et
4244 al. 2012).

4245 Steel et al. (2015) presented evidence that the response of fire regime to past fire suppression varies
4246 with forest type and the degree to which fire in an ecosystem is fuel-limited or climate-limited. Forests
4247 with fire regimes that are more fuel-limited (e.g., yellow pine forests and mixed conifer forests found in
4248 much of the interior portion of the Northern Spotted Owl range in California) should experience

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4249 increases in fire severity following periods of fire suppression, whereas forests with fire regimes that
4250 have been historically climate-limited (e.g., redwood forests) would be less altered by a history of
4251 suppression. Using data on fire severity for 660 fires that occurred on USFS land in California between
4252 1984 and 2011, Steel et al. (2015) showed that the proportion of fires burning at high severity has
4253 increased for fuel-limited forest types. This increase in severity was correlated to indicators of fire
4254 suppression for much of California; however, the Klamath bioregion did not show this relationship. This
4255 suggests that fire severity, or at least the occurrence of high severity fire in the Klamath bioregion may
4256 be more limited by climate than by fuel loads. This may explain inconsistent observations of fire severity
4257 trends for the Klamath region, with measured proportions of high intensity fire varying on a case-by-
4258 case basis, depending on climatic conditions during the fire.

4259 Where increases in fire size or severity have been observed in recent years in forests of the western
4260 United States, it has often been attributed to increased densities of fuels and development of ladder
4261 fuels as a consequence of fire suppression. Fire suppression and exclusion in ponderosa pine forests has
4262 been successful at reducing the frequency of fire which allowed for the development of shade-tolerant
4263 trees and understory vegetation in the previously open forests, and resulted in an increase in stand
4264 density (Taylor 2000). Resource-stressed stands are more susceptible to insects and disease which
4265 results in an increase in weakened or dead trees and heavy fuel loadings (Hessburg et al. 2005, Davis et
4266 al. 2011). This has led to fuel characteristics in ponderosa pine forests that can support larger and more
4267 severe wildfires (Hessburg et al. 2005). Large, severe fires in the dry eastern Cascades of Oregon and
4268 Washington have occurred in recent years (Davis et al. 2011), and the potential remains for the loss of
4269 large amounts of nesting and roosting habitat.

4270 Past management practices that have established more homogeneous even-aged forests (e.g., fire
4271 suppression, livestock grazing, and timber harvest practices) may provide forest conditions that are
4272 conducive to high-severity fires in forests with fire regimes that were historically fuel-limited. Repeated
4273 selection cutting of the largest trees had the effect of advancing secondary succession, resulting in
4274 younger forests with higher density, fire-intolerant trees (Hessburg et al. 2005). Recent large, high-
4275 severity fires and timber harvest practices have expanded the amount of even-aged plantations,
4276 hardwood stands, and shrublands (Skinner et al. 2006). Prior to fire suppression, the forest landscape in
4277 the Klamath Mountains contained stands of even-aged forests, but they do not appear to have occupied
4278 extensive areas (Taylor and Skinner 1998, 2003, Skinner et al. 2006). Odion et al. (2004) reported that
4279 plantations occur in one-third of the roaded landscape in their large fire study area in 1987. Extensive
4280 areas of young even-aged forests that have resulted from a combination of past fire and past timber
4281 harvest practices may amplify conditions for repeated high-severity fires compared to heterogeneous
4282 forests that were created by historical patterns of mixed-severity fires (Spies et al. 2006). A positive
4283 feedback resulting from past timber management and fire suppression practices, existence of increased
4284 even-aged stands in the forest matrix, and future high-severity fire has the potential to support a new
4285 forest matrix with stable or increasing amounts of even-aged forest and decreased heterogeneity
4286 (Skinner et al. 2006).

4287 Several studies have determined a strong link between changes in fire extent, severity and season, with
4288 low precipitation and high temperatures. In addition to land-use history over the last century, climate

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variables (e.g., precipitation, temperature) have been evaluated as potential causes of recent increases in large wildfires. There is an important distinction between these two potential causes. Changes in forests brought about by land-use history may be reversible through management actions, such as forest thinning and prescribed fire, while reversing trends in climate warming are unlikely in the near future (Westerling et al. 2006, Littell et al. 2009). Littell et al. (2009) found that in areas with low fuel loads the impacts could be lessened through fuel reduction prescriptions, however in areas that are experiencing low precipitation, this may prove less useful).

Under various climate change scenarios (as discussed in the Climate Change section of this report), fire seasons have been predicted to be longer and fire sizes larger (McKenzie et al. 2004, Westerling and Bryant 2008, Littell et al. 2009, Miller et al. 2009, Westerling et al. 2011). For example, McKenzie et al. (2004) found that extreme fire weather (e.g., hot dry summers) in western America will influence the severity and the total area burned, with the duration of the fire season lengthened with more fires occurring early and later in the typical fire season. Westerling et al. (2006) found that periods with large fire occurrences corresponded with a shift toward warm springs and longer summer dry seasons, and suggested that both land use and climate have contributed to increased fire risk, but that broad-scale increases across the western U.S. were driven primarily by recent trends in climate.

Compared to pre-European settlement, Miller et al. (2009) found that high severity fires in low- to mid-elevation forests are increasing of California and western Nevada. Miller et al. (2009) suggests that snow water deficits, earlier snowmelt, lengthening of the fire season, worsening drought conditions, low fuel moisture, and increase of forest fuel availability all play a role in how forests are in a position to burn more often and at higher severity. In this study, types of forested land most impacted by high severity fires include those on National Forest land, those experiencing high resource extraction and rapid human population growth, and those supporting old growth dependent species (Miller et al. 2009).

Another study in the western United States supported theory that climate is a driving factor influencing fire extent in the 20th century, and fire regimes will vary dependent on fuel energy and water deficits (Littell et al. 2009). Low precipitation and high evapotranspiration in mountainous ecoprovinces of the western United States lead to low fuel moisture conditions; thus, creating a system at higher risk to combustion and fire spreading (Littell et al. 2009). Similar to Miller et al. (2009) findings, Littell et al. (2009) suggests low precipitation, warmer winters, reduced snowpack and drought effects lead to increases of forested area burned.

With future climate change, the continued occurrence of large, uncharacteristically severe fires may become increasingly common. These changes may in turn impact the habitat, distribution and abundance of sensitive species such as the Northern Spotted Owl.

Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat

Variation in fire severity has an important influence on forest structural diversity because low-severity fires kill few trees while high-severity fires may kill all trees in a stand (Taylor and Skinner 2003). High-severity fires tend to result in even-aged stands while lower severity fires result in forests with multiple

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age classes. In much of California, the Northern Spotted Owl evolved in a landscape of frequent, mixed-severity fire, with most burns occurring at low severity and a relatively small amount of burns occurring at high severity. In the drier portion of the Northern Spotted Owl range, the species is likely adapted to the heterogeneous landscape resulting from regular, mixed-severity fire. Prior to fire suppression, the frequent occurrence of mixed-severity fires in large portions of the Klamath and Cascade ranges, along with the resulting complex landscape (e.g., older forests with openings of other forest types intermixed with nonforested areas) was prominent throughout the region. The historical mixed fire regime in the Klamath region may have benefited Northern Spotted Owl habitat by maintaining areas of older forests with dense canopies and complex structure, while also providing a heterogeneous landscape composed of multiple forest ages and structure. This pattern could have supported high quality habitat mosaics of nesting and roosting habitat and diverse foraging habitat which lead to high survival and reproductive success (Franklin et al. 2000).

Current fire regime and its potential to impact Northern Spotted Owl habitat depends on a number of factors including: fire management history, logging history, forest type, historical fire regime, weather patterns and climate change. Additionally, observed impact to Northern Spotted Owl is likely complicated by occurrence of post-fire salvage logging. Although forest heterogeneity has decreased with recent management practices, the forests of the Klamath Mountains continue to provide habitat for Northern Spotted Owl. More information is needed on the effect of historical fire suppression and current fire regimes on owl habitat, especially on the quality of habitat as assessed through demographic rates at individual owl territories. Most fires in the Klamath region continue to burn under historical mixed regimes that can contribute to a heterogeneous forest landscape. However, recent large fires are cause for concern for the future stability of forest conditions in the region, especially considering the higher percentage experiencing high-severity burns. Large amounts of Northern Spotted Owl nesting and roosting habitat has been lost to wildfire since implementation of the NWFP, with the majority being lost in a few very large fires (e.g., the Biscuit Fire of 2002) (Davis et al. 2011). Fires have been more frequent during dry years (Cook et al. 1996) and extreme weather events influence the occurrence of large, landscape-scale fires (Miller and Urban 2000). Wildfire has been the leading cause of nesting and roosting habitat loss on federal lands in recent decades; if large fires continue to occur in the future, much more habitat may be lost.

Historical fire suppression and exclusion in ponderosa pine forests in the Cascades was successful at reducing the frequency of fire which allowed for the development of shade-tolerant trees and understory vegetation in the previously open forests, and resulted in an increase in stand density (Taylor 2000). This may have improved nesting and roosting habitat conditions for Northern Spotted Owls in these forests compared to the pre-suppression period. However, high densities of younger trees as a result of fire suppression and timber management practices have created conditions with potential for stand-replacement fires in ponderosa pine forests. Ideally a landscape-scale management strategy for these forests would retain large, dense patches of forests embedded in a matrix with reduced stand densities to limit the potential for stand-replacement fire and competitive pressure on old trees (Thomas et al. 2006).

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With the complexity of fire regimes in the state, the sometimes equivocal effects on Northern Spotted Owls, the uncertain contribution of fuel build-up, and climate influences on future fire frequency and severity, there has been disagreement on the level of risk that fire poses in the dry portions of the Northern Spotted Owl range. Hanson et al. (2009) reported that the risk of fire to Northern Spotted Owl habitat in the dry provinces had been overestimated in the 2008 Recovery Plan, which included ongoing loss of habitat as a result of timber harvest and fire as threats to the Spotted Owl (USFWS 2008a). This claim of overestimation was made based on calculated rates of old-forest recruitment exceeding rates of high severity fire in old-forests (Hanson et al. 2009). Spies et al. (2010) criticized the findings of Hanson et al. (2009), stating that an incorrect threshold was used to estimate extent of high severity fire and that an incorrect depiction of error was used to support selection of the threshold. Spies et al. (2010) also disagreed with the methodology used by Hanson et al. (2009) to estimate the rate of recruitment of old forests.

This debate on the risk of fire to Northern Spotted Owl habitat has important management implications. If recent and projected changes in fire size or severity continue to remove large amounts of nesting and roosting habitat, fuel treatments (e.g., thinning and prescribed fire) to reduce fire risk may have long-term benefits to owls by encouraging the development and maintenance of older forest patches while limiting the risk of stand-replacing fires. However, if recent large high severity fires are an anomaly and recruitment of old forest outpaces losses to high severity fire, natural processes can be incorporated into management plans to shape Spotted Owl habitat on the dry province landscape. Hanson et al. (2010) recommended small-scale experiments to study owl response to fuel treatments rather than large-scale implementation. Risks are not likely to be uniform across the range, with ponderosa pine forests likely having a different response to past management than mixed-conifer forests of the Klamath, for example. The 2011 Revised Recovery Plan recommends formation of working groups to inform management in both the Klamath and dry Cascade provinces (USFWS 2011a).

Climate Change

According to global and regional climate scenarios, many species will be required to adapt to changes in temperature, precipitation, forest structure, etc., or face eminent declines or extirpation. The degree of threat varies based on species and region. Climate change scenarios have been modeled across the range of the Northern Spotted Owl, including in California. Several studies have been conducted to assess the threat to Northern Spotted Owl specifically.

Climate Change Projection Modeling

In California, a multitude of climate change studies have been conducted. As noted by Pierce et al. (2012), a common theme among the California-specific studies indicates temperature showing a consistent positive trend, but changes in precipitation vary. Generally, most studies agree that California will retain its Mediterranean climate of cool/wet winters and hot/dry summers, yet the degree of wetness/dryness will be amplified (Lenihan et al. 2003, Cayan et al. 2012).

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The projected climate model simulations from Cayan et al. (2012) exhibit warming over California, with a mid-century rise of approximately 1°C to 3°C (1.8°F to 5.4°F), and 2°C to 5°C (3.6°F to 9°F) rise by end-of-twenty-first century. Pierce et al. (2012) showed an average yearly increase in temperature over California of 2.4°C by the 2060s, with coastal areas showing less warming (1.9°C) than interior areas (2.6°C). Westerling and Bryant (2008) predicted an average increase of 4.3°C in California by 2070–2099. Seasonally, the summer and fall months exhibit greater warming than winter and spring months (Cayan et al. 2012, Pierce et al. 2012), with the degree of warming increasing as one moves from the coast to the interior of the state (Cayan et al. 2012). Extreme temperature events (i.e., frequency of extreme hot days) will become more common place and may take place earlier in the season (Cayan et al. 2012).

Climate projection modeling conducted by Cayan et al. (2012) show a high degree of variability between month-to-month and year-to-year precipitation with slight drying tendencies in some areas of California, which may suggest that California will remain at risk to drought and flooding events, with more prominent changes in the southern portion of the state than the northern portion. Seasonal changes in precipitation included a somewhat contracted wet season, with less precipitation during late winter and spring than during the core winter months (Cayan et al. 2012). Pierce et al. (2012) found precipitation decreased overall in the southern portion of California (<10%) by the 2060s, but remained unchanged from historical levels in the northern portion of the state. Seasonally, winters in the northern portion of the state were wetter and offset by drier conditions the rest of the year by the 2060s, while the southern part of the state showed moderate decreases in fall, winter, and spring but stronger increases in summer (Pierce et al. 2012).

Dalton et al. (2013) summarizes climate projection models for the Coastal, Cascade and Rocky Mountain ranges of Washington, Oregon and Idaho (e.g., Northwest). This paper indicates that the region showed an overall increase of temperature year-round (warming of at least 0.5 °C (0.9 °F) in every season), but more prominent warming during summer months. Modeling showed mixed results for annual precipitation, indicating little change from present (models ranged from –4.7% to +13.5%). Seasonally, most models showed a decrease in precipitation during summer months and increased precipitation during the other seasons (the largest projected change of about –30%). Dalton et al. (2013) climate models are in agreement that heat extremes will increase and cold extremes will decrease. Along the Northwest coast, sea level rise was projected to rise 4 to 56 in (9–143 cm) by 2100, with significant local variations.

Climate Change Impacts to Forests

In the Northwest and in California, changes in precipitation and temperature may impact forest distribution, growth, and structure (Lenihan et al. 2003, Dalton et al. 2013, Vose et al. 2012, McIntyre et al. 2015). Most climate projection models indicate upward elevational shift and a northward latitudinal shift in forest habitats (Vose et al. 2012). In climate projection scenarios specific to California, Lenihan et al. (2003) noted the most notable response to increase temperature was a shift from conifer-dominated forests to mixed conifer-hardwood forests in the northern half of the state (e.g., the replacement of Douglas fir-white fir forest by Douglas fir-tan oak forest in the northwest) and an expansion of conifer forests into the northeast portion of the state (e.g., Modoc Plateau) by the 21st century. McIntyre et al.

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(2015) found similar results when comparing historic forest survey data (1930s) with recent surveys (2000s) to elucidate forest structure and composition shifts over time within the entire latitudinal extent of forests in California. This study found that today's forests are exhibiting an increase dominance of oaks (*Quercus*) at the expense of pines (*Pinus*). McIntyre et al. (2015) also found that across the 120,000km² study area, large trees declined by 50% with a 19% decline in average basal area and associated biomass since the early 1900s. Understanding the shifts in structure and species composition is complex, but McIntyre et al. (2015) partially attributed these shifts to water deficits within California forests (e.g., drought), while acknowledging other contributing factors such as logging and fire suppression (McIntyre et al. 2015). Conifer-dominated forests (e.g., redwood and closed-cone pine forests) along the north-central coast of California (e.g., Crescent City south to Monterey) were projected to advance, resulting in redwood forests shifting inland into Douglas-fir-tan oak forests (Lenihan et al. 2003). Dalton et al. (2012) found that Douglas-fir forests in the Northwest may experience substantial declines through the 21st century. Tree productivity along California's north-central coastal and at high elevation forests was shown to increase in response to increased growing season temperatures; however, increases in productivity along the coast would only be seen if there was a persistence of coastal summer fog (Lenihan et al. 2003). Lenihan et al. (2003) suggests that if summer fog were to decrease in concert with increased temperatures, productivity of redwood forests along the coast would suffer reductions, or worse, would be eliminated entirely.

Vulnerability to disturbance, such as wildfire, disease and insect outbreaks, is expected to increase in most forests in the Northwest and may change forest composition and structure depending on changes to climate (Dalton et al. 2012, Vose et al. 2012). According to Davis et al. (2011), one of the objectives of US Forest Service is to develop projections for wildfire regimes and habitat shifts due to changing climate and increased threats from wildfire, disease and insect outbreaks. Vose et al. (2012) effectively summarizes the nationwide effects of climate driven disturbance as follows:

- Wildfire will increase causing a doubling of area burned by mid-21st century
- Insect infestations (e.g., bark beetle in the western US) will expand
- Invasive species will likely become more widespread, and especially in areas with increased disturbance and in dry forests
- Increased flooding, erosion and sediment transport caused by increase precipitation, area of large burned areas, and rain-snow ratios
- Increases in drought occurrences, exacerbating other disturbances (e.g., fire, insect outbreaks, invasive species), which will lead to higher tree mortality, decreased regeneration in some tree species, and alteration of tree species composition and structure

Climate modeling studies agree that forest wildfire occurrence and severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and longer drier summers (Swetnam 1993, National Assessment Synthesis Team 2000, Houghten et al. 2001, Lenihan et al. 2003, Westerling et al. 2006, Westerling and Bryant 2008, McKenzie and Littell 2011, Vose et al. 2012). Spracklen et al. (2009) projected that forests of the Pacific Northwest forests will experience increases in mean annual area burned, with a projected increase of 175% by 2050 compared to areas

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burned between 1996 and 2005. This increase will likely negatively impact old-growth forests and the species that inhabit them (Dalton et al. 2012, Vose et al. 2012). By evaluating fire history and climatic data in forested areas across the western United States over a 34-year period, Westerling et al. (2006) tested the contributions of land use and climate conditions on occurrence of large fires. Over this study period, the frequency and size of wildfires showed a marked increase in the mid-1980s; a large portion of this increase occurred in the range of the Spotted Owl in California (Sierra Nevada, southern Cascades, and Coast Ranges of northern California). The period of increase in large fire occurrence corresponded with a shift toward warm springs and longer summer dry seasons (Westerling et al. 2006). The authors concluded that both land use and climate have contributed to increased fire risk, but that broad-scale increases across the western U.S. were driven primarily by recent trends in climate. For California as a whole, by the end of the 21st century, risk of large fire will increase between 12 and 53 percent compared to observed fire regimes between 1980 and 1999, and for northern and southern California, large fires will increase 15 to 90 percent and -29 to 28 percent, respectively (Westerling and Bryant 2008). See the Wildfire section above for more detailed discussion on wildfire impacts to forest systems.

Climate Change Impacts to Northern Spotted Owl

Northern Spotted Owls utilize older structurally complex forests, in part, to facilitate thermoregulation and to provide protection from predators. Forest type and age within owl habitat varies by region. Coastal regions are wetter and cooler and tend to be redwood species dominant and of a younger age class, whereas inland regions are drier and warmer and tend to be mixed conifer/hardwood or Douglas-fir dominant.

Most climate projection scenarios agree that the forests in the Northern Spotted Owl's range will have wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased frequency and intensity of disturbance events. According to many climate projections, the frequency and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will increase over time. Extreme climatic variation has been linked to sudden large-scale mortality in avian populations in the past (Tomba 1971, Johnson et al. 1991, and Smith et al. 1991 as cited in Franklin et al. 2000), and the literature studying Spotted Owl response to climate supports this.

Northern Spotted Owl survival is thought linked to precipitation patterns. Olson et al. (2004) stated that survival was negatively associated with early-nesting season precipitation, and positively associated with late-nesting season precipitation. Population growth for Northern Spotted Owls range-wide (Washington, Oregon and California) was positively associated with wetter conditions during the growing season (May through October) due to more favorable conditions for prey species, but negatively associated with cold/wet winters and nesting seasons, and during hot summers on four of the six study areas (Glenn et al. 2010). Over the extent of late-successional reserve land covered by the NWFP, Carroll (2010) predicted that winter precipitation was closely associated with a decrease in Northern Spotted Owl survival and recruitment (i.e., the entirety of the Northern Spotted Owl range in Oregon, Washington and California). Using vegetation and climate variables, model results in Carroll

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4519 (2010) predicted an initial northward expansion of high quality owl habitat, followed by a contraction as
4520 climate variables intensify over time.

4521 In the Coastal and Klamath Mountains of northwestern California, Franklin et al. (2000) thoroughly
4522 examined the effects of climate on temporal and spatial variation of Northern Spotted Owl survival,
4523 reproductive output, and recruitment. In these models, climate explained most of the temporal
4524 variation in life history traits. The study suggested that the period most impacted by climate was during
4525 the spring, presumed largely due to higher energetic demands during the breeding season, as well as
4526 prey abundance and availability. Franklin et al. (2000) states, “extreme climate conditions during the
4527 early nesting period may exacerbate an energetic stress on an individual by decreasing it’s time to
4528 starvation.” However, the winter period did explain variation in recruitment, thought to be a function of
4529 reduced survival of young during their first year.

4530 In Oregon and Washington, Glenn et al. (2011) found a negative association between Northern Spotted
4531 Owl reproduction (number of young fledged) and cold wet nesting season, thought to be a function of
4532 loss of eggs or young to exposure or terminating incubation (Forsman et al. 1984). Whereas,
4533 reproduction was positively associated with late nesting season precipitation and negatively associated
4534 with warm temperatures, thought to be a function of reduced prey abundance and availability.
4535 Interestingly Glenn et al. (2011) also found that number of young fledged per year declined when
4536 precipitation in the year prior deviated from normal, and that number of young fledged per year
4537 increased following warm wet dispersal seasons. Some of these results differ from California studies
4538 such as Franklin et al. (2000), and may be a function of differing habitat, climate and targeted prey
4539 species. Regardless, the study suggests that Northern Spotted Owl reproductive success involves a
4540 complex relationship between prey populations, body condition and climate prior to and within the
4541 nesting season; a statement that, given the current literature on the species, certainly holds true for the
4542 species in California.

4543 The literature also indicates that Spotted Owls are sensitive to heat stress (Franklin et al. 2000,
4544 Weathers et al. 2001), which may be more problematic as temperatures rise over time. For the
4545 California Spotted Owl, Weathers et al. (2001) found that when temperatures reached between 30 and
4546 34°C, a relatively moderate level, owls increased behavioral heat responses (e.g., increase respiratory
4547 rate, gaping, wing drooping).

4548 As previously discussed, structural complexity (broken top trees, snags, overhead cover) is an important
4549 habitat component for Northern Spotted Owls. Structural complexity is an important factor in
4550 determining the availability of suitable nest sites. Rockweit et al. (2012) found that nest type selection
4551 played a role in Northern Spotted Owl reproductive success in California during period of inclement
4552 weather (i.e., low temperatures and high winds). Nests that were more exposed to the elements, such
4553 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at
4554 protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must
4555 include structurally complexity to provide nesting options with proper protection. The intensity of
4556 disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or
4557 detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced

Comment [ABF96]: See also:

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4558 when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may
4559 increase the level of structural complexity.

4560 Habitat loss and alteration due to heightened disturbance events (e.g., wildfire, disease, insect
4561 outbreaks), may also impact forest species, such as the Northern Spotted Owl, by intensifying
4562 competitive pressure from other species, such as Barred Owl (Lenihan et al. 2003, Carroll 2010).

4563 Direct mortality of Spotted Owls from wildfire will likely increase as frequency and intensity of wildfires
4564 increases. Indirect impacts may also include an increased level of predation if there is loss of older or
4565 structurally complex forests. However, neither direct mortality nor increased predation is specifically
4566 addressed in the literature.

4567 To better understand potential climatic impacts to Northern Spotted Owls, the Department compiled
4568 average 30-year (1980-2010) and 5-year (2010-2014) precipitation and temperature data and calculated
4569 the percent change within the owls range. Decreases in precipitation were most apparent in the
4570 southern portion of the coastal range (Marin, Sonoma and Mendocino counties), and within the interior
4571 range (Figure 25). Increases of precipitation were more limited, with increases seen in a small portion of
4572 northern Trinity County, and scattered within Humboldt and Del Norte counties. This analysis generally
4573 shows a drying trend throughout the owl's range, except in the northern portion of the coastal province
4574 and some small portion of the Klamath province.

Comment [ABF97]: See my General Comment 5 under the THREATS section

4575 Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-
4576 August) and winter months (December-February) separately. Comparing the 30-year average with the 5-
4577 year average, temperature increases during the summer months were seen mostly within the north and
4578 northwest portions of Siskiyou County (northern portion of the Klamath and Cascade provinces), and
4579 along scattered portions of the coastal province (Figure 26). As shown in Figure 26, temperature
4580 decreases in the summer months were seen most prominently within the rest of the interior (Klamath
4581 and Cascade provinces). During the winter months, temperature increases were seen within interior
4582 (Klamath and Cascade provinces), while decreases were seen most prominently in the coastal province
4583 (Figure 27). This analysis generally shows warmer winters and cooler summers compared to normal
4584 within the interior portion of the Northern Spotted Owl range, and cooler winters and warmer summers
4585 along the coastal portion of the range.

4586 It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many
4587 climate projections forecasting steady changes in the future. Climate change studies predict future
4588 conditions that may negatively impact owls, such as wet and cold springs, more frequent and severe
4589 summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased
4590 frequency of severe wildfire events. Yet in some instances predicted future conditions, such as increased
4591 frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to
4592 the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change
4593 predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other
4594 areas of the range. Looking at past precipitation and temperature trends, drying trends across most of
4595 the owl's range in California coupled with warmer winters and cooler summers in the interior and cooler

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winters and warmer summers along the coast may play a role in both owl and prey population dynamics. More research is needed to assess the extent of these climate impacts on survival, population growth and reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of climate change outweigh the positive ones.

Barred Owl

Barred Owl Expansion and Current Status in California

Historically, Barred Owls were residents of the eastern United States and southern Canada, east of the Great Plains and south of the boreal forest, and also in disjunct regions of south-central Mexico (Mazur and James 2000). Based on genetic analysis, Barrowclough et al (2011) found the disjunct Mexican populations to be distinct from populations in the United States and Canada at the species level, and recommended they be recognized as *Strix sartorii*. Barred Owls continue to occupy their historical range, and during the past century have expanded their range to western North America.

The timing and route of the Barred Owl range expansion into western North America has been debated by the scientific community and is not resolved. An early and long-held view has been that Barred Owls expanded their range to the west via the boreal forests of Canada (Grant 1966, Hamer 1988, Houston and McGowan 1999, Holt et al. 2001). Livezey (2009a) suggested a slightly different pattern of expansion based on records for more than 12,500 Barred Owl detections from 1873 to 2008. He suggested that the expansion began via riparian forests of the Missouri, Yellowstone, and Musselshell rivers of the northern Great Plains to the forested mountains of western Montana at the end of the 19th century (Figure 28). From Montana, he suggests that Barred Owls then expanded their range in multiple directions, including to the north and then east, where they encountered Barred Owls that were expanding their range west through the boreal forests of Canada. Whether the initial range expansion was via the boreal forest of Canada or the riparian corridors of the northern Great Plains, once Barred Owls reached British Columbia in the 1940s, they continued their range expansion to the north and west across Canada to southeastern Alaska, and south through Washington, Oregon, and California (USFWS 2011a, USFWS 2013). The range of the Barred Owl now completely overlaps the range of the Northern Spotted Owl from southwest British Columbia south along the western portion of Washington, Oregon, and northern California, and also includes a significant portion of the range of the California Spotted Owl.

Barred Owls were first detected in California in 1976 (Dark et al. 1998, B. Marcot in Livezey 2009a). From then until 1996, 61 Barred Owl sites were identified in California (Dark et al. 1998). The majority of these sites (73%) were occupied by single owls. The first report of breeding in California was in 1991 (T. Hacking in Dark et al. 1998) and the first sighting in the Sierra Nevada was in 1991. The rate of detections of Barred Owls in California accelerated during the mid-1990s (Dark et al. 1998) and by 1996 Barred Owls had been detected as far south as Sonoma County in western California and Yuba County in the Sierra Nevada. Forsman et al. (2011, Appendix B) presented data showing that the rate of detection continued to accelerate through the 2000s. Currently, the known range of the Barred Owl in California

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4633 extends along the coast south to Marin County (Jennings et al. 2011, Ellis et al. 2013) and to Tulare
4634 County in the Sierra Nevada.

4635 The Department has processed data for 1,970³ Barred Owl occurrences in California (Figure 29), and 111
4636 additional occurrences of Barred-Spotted Owl hybrids. Occurrences include all detections of barred
4637 owls, whether or not they were associated with a nest or territory.

4638 Following the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two
4639 species have occasionally been observed. The majority of hybrids genetically sampled resulted from a
4640 cross between a female Barred Owl and a male Spotted Owl (Haig et al. 2004, Kelly and Forsman 2004).
4641 Generally second generation hybrids are difficult to distinguish from barred or Spotted Owls using field
4642 identification only and genetic samples may be the only sure way of identification (Kelly and Forsman
4643 2004). Both first and second generation hybrids were found to be reproductively viable to some extent
4644 (Kelly and Forsman 2004). Haig et al. (2004) found that the two species DNA sequences showed a large
4645 divergence and could be separated into distinct clades with no signs of previous introgression.

4646 *Potential Mechanisms of Barred Owl Range Expansion*

4647 Factors that may have facilitated the range expansion have been debated in the literature at length. As
4648 mentioned above, two possible routes for the initial expansion from eastern North America have been
4649 suggested (i.e., riparian forests of the northern Great Plains and the boreal forest of Canada). It has been
4650 speculated that an ecological barrier existed prior to the end of the 19th century and that changes, either
4651 anthropogenic or natural, removed the barrier, and allowed for the initial westward expansion of the
4652 Barred Owl range.

4653 The most prominent theory is that an increase in the number of trees and forested areas supported the
4654 expansion by providing suitable Barred Owl habitat where before there was none (e.g., within the Great
4655 Plains). The relatively fast Barred Owl range expansion coincides with a period of dramatic increases in
4656 wooded habitat across the northern Great Plains and the boreal forests of Canada following arrival of
4657 European settlers. Explanations for an increase in the number of trees are anthropogenic and include
4658 fire suppression, tree planting (including shelterbelts), extirpation of bison, and to a lesser extent
4659 reductions in beaver, elk and deer populations on the northern Great Plains due to market hunting (Dark
4660 et al. 1998, Wright and Hayward 1998, R. Gutiérrez in Levy 2004, Livezey 2009b). Livezey (2009b)
4661 evaluated the plausibility of barriers to range expansion that have been proposed. He provided strong

³ The 1,970 occurrences processed to date represent a subset of available data and come from 2 general sources: 1) state and private researchers, biologists and foresters from 1978-2013 and 2) the Forest Service's NRIS database with records from 1992-2011. Data omitted due to time constraints includes 1) hard copy data, 2) 2012-2013 NRIS detections and 3) NRIS detections that were within 1 mile of processed data to avoid duplicates; this data, not including duplicates, will be added in the future. An updated version of NRIS containing 2012 and 2013 detections is still needed. Additional data from the 2013 field season is also yet to be submitted. There is likely more data in holding and data from additional sources that has not been submitted.

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evidence that the northern Great Plains were largely treeless prior to the range expansion, a finding that supported a lack of habitat as a potential barrier. He also evaluated a number of anthropogenic changes (as noted above) preceding or coincident with the expansion and that are likely to have greatly increased the forest habitat in the region. Livezey concluded that the most plausible explanation for an ecological barrier that existed prior to range expansion, the removal of which coincided with range expansion, is an increase in forest habitat, first along the rivers and later in the boreal forest. Tree planting and fires suppression are obvious causes of the increase in wooded area, and the timing of these precedes the expansion of Barred Owl to the west. Huge numbers of bison destroyed small wooded areas on the Great Plains through rubbing on older trees and browsing or trampling of young trees (Livezey 2009b). The extirpation of bison precedes the increase in wooded habitat on the northern Great Plains. Elk, deer, and beaver have also been shown to have local effects on forest habitat, and may have contributed to suppression of forests in the Great Plains, especially in the limited wooded habitat along riparian corridors (Livezey 2009b).

Another theory is that increases in temperature may have improved habitat value for Barred Owls in the boreal forest (Johnson 1994, Wright and Hayward 1998, Monahan and Hijmans 2007). This theory is based on an assumption that the boreal forests of southern Canada were too cold to be tolerated by Barred Owls, and that a warming climate brought these forests into the range of temperature tolerance for the species, thereby eliminating a natural barrier to Barred Owl range expansion. Because portions of the current range of Barred Owls (e.g., northern Alberta and British Columbia, the Northwest Territories) are much colder than the forests of southern Canada, Livezey (2009b) rejected the hypothesis that a thermal barrier was preventing range expansion, but he suggests conducting additional research on the thermal tolerances of Barred Owls. Additionally, the temperature increase referenced in the literature occurred in part after the Barred Owl range expansion had begun (Johnson 1994, Monahan and Hijmans 2007), calling this mechanism of range expansion into question.

Once Barred Owls expanded across the middle of the continent, they encountered forests of the Rocky Mountains and the Pacific Northwest. Timber harvests may have facilitated the further expansion of the range by creating a mosaic of more open forest habitat that might be favored by a habitat generalist like the Barred Owl (Hamer et al. 1989, Dark et al. 1998). However, Barred Owls have become established in a variety of habitats, including mature forests that have not been harvested, challenging this as a factor in the further expansion of the range (USFWS 2013). Because Barred Owls are habitat and prey generalists (as explained below), the suggestion that they adapted to use of a novel (coniferous forest) habitat, which then allowed them to spread through the boreal forest and the forests of the west has largely been dismissed (Livezey 2009b, USFWS 2013).

Spotted Owl and Barred Owl Habitat, Prey Selection, and Home Range

Barred Owls tend to select low to high elevation areas with gentle slopes, large overstory tree with expansive crown diameter, and evergreen stands with a dense canopy, but will also nest in areas with young trees, deciduous tree species and open areas (Herter and Hicks 2000, Buchanan et al. 2004, Gremel 2005, Hamer et al. 2007, Jennings et al. 2011, Mazur and James 2000, Pearson and Livezey 2003, Singleton et al. 2010). Recently, Wiens et al. (2014) determined that Barred Owls selected a broad range

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4701 of forest types in western Oregon, but were more strongly associated with large hardwood and conifer
4702 trees within relatively flat areas along streams. In the eastern Cascades Range in Washington, Singleton
4703 (2015) found Barred Owls used structurally diverse mixed grand fir and Douglas-fir forests during the
4704 breeding season more often than open ponderosa pine or simple-structure Douglas-fir forests, with less
4705 selection among forest types during the non-breeding season. Spotted Owls may have a stronger affinity
4706 than Barred Owls to Douglas-fir dominant forests and more abundant dwarf mistletoe infestations, an
4707 important habitat feature for nesting Spotted Owls in the Washington’s eastern Cascades (Singleton
4708 2015). Similarities between Barred Owl and Spotted Owl habitat preferences include selection of old
4709 forests with closed canopy and a high degree of structural complexity for nesting and roosting activities
4710 (Mazur et al. 2000, Singleton et al. 2010, Wiens et al. 2014, Singleton 2015). As Wiens et al (2014) points
4711 out, the similar habitat preference for older forests highlights the importance for maintaining this forest
4712 type on the landscape because a decrease in older forests will likely increase competitive pressure
4713 between the two species. Differences of habitat selection include the tendency for selection of lower
4714 elevation sites with gentle slopes (e.g., valley floors) by Barred Owls, the use of a larger variety of forest
4715 types by Barred Owls, the stronger dependence on Douglas-fir dominant forests by Spotted Owls, and
4716 more abundant mistletoe infestations by Spotted Owls. Currently, there is no indication that the two
4717 species can coexist, sharing the same habitat and prey-base, because there is little evidence that nesting
4718 habitat or prey-base can be adequately partitioned to prevent competition (Gutiérrez et al. 2007, Dugger
4719 et al. 2011, Singleton 2015).

4720 Home range analyses show the importance of mature forests for nesting by both Barred and Spotted
4721 Owls; however, Barred Owls select other forest cover types similar to their availability whereas Spotted
4722 Owls are more tightly associated with old forests (Hamer et al. 2007, Singleton et al. 2010). Home ranges
4723 for both species have been found to be smaller in old mature forests; however, within forest types,
4724 home ranges of Spotted Owls are 3 to 4 times larger than those of Barred Owls (Hamer et al. 2007,
4725 Singleton et al. 2010, Wiens et al. 2014). In a western Oregon study, Barred Owl home range and core
4726 area use (i.e., the portion of the fixed-kernel breeding season home range in which use exceeded that
4727 expected under a null model of a uniform distribution of space-use) was 581 ha and 188 ha,
4728 respectively; whereas Northern Spotted Owl home range and core area use was much larger - 1843 ha
4729 and 305 ha, respectively (Wiens et al. 2014). In some areas of sympatry, little overlap exists between
4730 Barred and Spotted Owl home ranges, which is indicative of competitive exclusion of Spotted Owls by
4731 Barred Owls (Hamer et al. 2007, Singleton et al. 2010). However, Wiens et al. (2014) found overlap
4732 between the two species with adjacent territories in western Oregon to be 81%, with most space
4733 sharing in the foraging areas outside of the core area use.

4734 Barred Owls are opportunistic hunters that consume a wide array of prey, including small mammals
4735 ranging from rabbits to bats, small to medium sized birds, amphibians, reptiles, fish, and invertebrates;
4736 however, mammals make up a majority of prey items (Hamer et al. 2001, Mazur and James 2000),
4737 making them more of a generalist than Spotted Owls in their selection of prey. Hamer et al. (2007)
4738 measured a diet overlap by biomass of 76% between Spotted and Barred Owls in a region of sympatry in
4739 the Cascades of Washington. Wiens et al. (2014) found dietary overlap by biomass between the two
4740 species to be moderate (41%) with Northern flying squirrel, woodrat and lagomorph species the primary

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4741 prey for both (84% of Northern Spotted Owl diet and 49% of Barred Owl diet). Both studies suggest
4742 competition for food resources between the two species.

4743 Prey species composition and density drive habitat selection and home range size for both owl species;
4744 however, Spotted Owls are more sensitive to fluctuations in prey abundance and availability than Barred
4745 Owls due to their more limited number of preferred prey species (Bond et al. 2013, Franklin et al. 2000,
4746 Hamer et al. 2007, Meyer et al. 1998, Thomas et al. 1990, Ward 1990, Zabel et al. 1995, Zabel et al.
4747 2003, Wiens et al. 2014). The narrow range of prey selected by Spotted Owls contributes to the need
4748 for much larger home ranges in comparison to Barred Owls.

4749 *Impacts of Barred Owls on Spotted Owls*

4750 Data is lacking to adequately assess Barred Owl abundance in western North America. However,
4751 Northern Spotted Owl populations are declining throughout most of their range. The USFWS holds
4752 periodic workshops with Northern Spotted Owl researchers to assess population parameters, such as
4753 abundance, trend and survival (USFWS 2013). These workshops have resulted in four published and one
4754 unpublished meta-analyses since 1994 (Burnham et al. 1994, 1996, Anthony et al. 2006, and Forsman et
4755 al. 2011). These analyses show that in areas where Barred Owls are present, the decline in Northern
4756 Spotted Owl abundance has been steeper than where the Barred Owl was absent. Declines were more
4757 prevalent where Barred Owls density was greatest. In addition, analyses determined that Northern
4758 Spotted Owl adult survival declined in a majority of the study areas in Washington, Oregon, and
4759 California where Barred Owls were present, with a more gradual decline in California sites (Forsman et
4760 al. 2011). The relatively lower rate of decline in California may be attributable to the relatively more
4761 recent Barred Owl expansion into California. The presence of Barred Owls in or near Spotted Owl
4762 territories appears to be impacting the abundance, fecundity, and survival of Spotted Owls (Olson et al.
4763 2004, Forsman et al. 2011). Wiens et al. (2014) found annual survival for Northern Spotted Owl in
4764 western Oregon lower (0.81, SE=0.05) than that of Barred Owl (0.92, SE=0.04), with a strong positive
4765 relationship on survival to old forests (>120 years) for both species. Northern Spotted Owl reproduction
4766 increased linearly with increasing distance from Barred Owl territory centers, and all Northern Spotted
4767 Owl nests failed when within 1.5 km (0.93 miles) of a Barred Owl nest (Wiens et al. 2014).

4768 The expansion of the Barred Owl range into that of the Spotted Owl has been documented mainly
4769 through incidental detections during Spotted Owl surveys. Based on these detections, numerous
4770 researchers have reported that Barred Owl numbers quickly increase after a short period of slow
4771 increase once they arrive in a new area (USFWS 2013). In the Oregon Cascades, Barred Owl detections
4772 increased from one initial detection in 1979 to over 700 detections by 1998 (Kelly 2001). Barred Owls
4773 can also quickly outnumber Spotted Owls; in the Northern Cascades in Washington, Barred Owl
4774 abundance was twice that of Spotted Owls within 17 years of the first detection (Hamer et al. 1988). In
4775 the range of the Spotted Owl, the density of Barred Owls is greatest in the north, where they have been
4776 present the longest (British Columbia and Washington), and fewer detections have been made in the
4777 southern edge of the range (California) where they have been present for a shorter duration (USFWS
4778 2013). Despite this general north-south gradient in the density of Barred Owls, Forsman et al. (2011)

Comment [ABF98]: Was not published (is an unpublished report). Fifth one was Franklin et al. 1999

Comment [ABF99]: Only Anthony et al 2006 and Forsman et al. 2011 included results on barred owl impacts

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4779 provide strong evidence of increasing Barred Owl populations throughout the range of the Northern
4780 Spotted Owl and California Spotted Owl.

4781 Barred Owl presence has also been determined to be negatively associated with Spotted Owl occupancy
4782 throughout the range of the Northern Spotted Owl (Olson et al. 2005, Kroll et al. 2010, Forsman et al.
4783 2011, Sovern et al. 2014). Studies have shown that Barred Owl presence influences whether Spotted
4784 Owls occupy a territory (Kelly 2001, Pearson and Livezey 2003, Gremel 2005, Sovern et al. 2014). In
4785 Olympic National Park, an area with historic Northern Spotted Owl territories, occupancy of Spotted
4786 Owls declined by almost 20 percent as Barred Owl presence increased by 15 percent between 1992 and
4787 2003 (Gremel 2005). It has also been determined that Spotted Owls will move activities away from areas
4788 with Barred Owl presence even if they do not move their territory (Kelly 2001, Gremel 2005). Within the
4789 Hoopa Valley Indian Reservation (Humboldt County, California), Barred Owls were detected in over 85%
4790 of all historic Northern Spotted Owl territories between 2009 and 2014 (Higley and Mendia 2013).
4791 Northern Spotted Owl occupancy in the Hoopa study area started a steep decline in 2004, in concert
4792 with a boom in Barred Owl occupancy; and in 2013, Northern Spotted Owl occupancy was down to
4793 0.595 while Barred Owl occupancy increased to 0.838 (95% CI) (Higley and Mendia 2013).

4794 For the Willow Creek Study Area (part of the NWC study area), Franklin et al. (2015) reported a mean λ
4795 of 0.975 (1985-2014; SE 0.012), indicating a decline in the Northern Spotted Owl population for this
4796 area. The mean survival rate was 0.848 (1985-2014; SE 0.009). Survival rate was thought to be
4797 negatively influenced by the presence of Barred Owl. The Willow Creek Study Area has experienced a
4798 dramatic increase in Barred Owl detections, from one barred owl site in 1991 to 22 in 2014 (Franklin et
4799 a. 2015). Spotted Owl territories having Barred Owl detections ranged between 0-37 within the same
4800 timeframe (Franklin et al. 2015).

4801 When Barred Owls were first detected in a Northern Spotted Owl territory on Green Diamond Resource
4802 Company land, Humboldt County, Northern Spotted Owls no longer responded to taped playback calls,
4803 demonstrating they were either absent from the territory or not responsive (Diller 2012). In 2014, there
4804 were 268 Barred Owl detections on Green Diamond Resource Company land, representing an estimated
4805 65 territories, and demonstrates a 76% increase in detections from 2011-2014 (GDRC 2015). Forty-eight
4806 of the 65 territories were within the density study area (GDRC 2015).

4807 Barred Owl removal experiments were conducted on Green Diamond Resource Company land to assess
4808 the impacts Barred Owls were having on Northern Spotted Owl presence (Diller 2012 and GDRC 2015).
4809 When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within
4810 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that
4811 some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to
4812 Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed
4813 (Diller 2012).

4814 During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley
4815 Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97%
4816 adults, 92.9% female, 65.3% male), with at least one Barred Owl removed from 28 historic Northern

Comment [ABF100]: Actually, the analysis of both survival rates and rates of population change indicated a negative effect of barred owl detections in spotted owl territories. This wasn't just a thought.

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4817 Spotted Owl territories, and >2 removed from 21 Northern Spotted Owl territories (Higley 2014).
4818 Spotted Owl occupancy since the removal has occurred has not yet been reported.

4819 Spotted Owls will reduce their calls or not call at all if Barred Owls are in the vicinity (Cozier et al. 2006,
4820 Diller 2012, Sovern et al. 2014), making it more difficult to detect Spotted Owls if Barred Owls are
4821 present. Thus, standard surveys might result in occupancy status being misclassified (e.g., a false-
4822 negative survey -- designating sites as unoccupied by Spotted Owls when in reality Spotted Owls are
4823 present but are not vocalizing). Beyond land management implications (e.g., timber harvest or not), this
4824 behavior shift by the Spotted Owl may also have implications for reproduction because calls are used to
4825 defend a territory and locate mates, and during pair bonding and prey delivery to the nest site (USFWS
4826 2013).

4827 The ecology of Barred Owls gives them a competitive advantage over Spotted Owls regarding
4828 reproductive success and productivity (Courtney et al. 2004, USFWS 2013). Barred Owls have larger
4829 clutches (1 to 5 chicks) than Spotted Owls (1 to 3 chicks), and Barred Owls may produce up to three
4830 clutches per season, both of which may lead to higher productivity (Gutiérrez et al. 1995, Mazur et al.
4831 2000, Gutiérrez et al. 2007). Some studies have found that Spotted Owls often do not breed every year,
4832 and that productivity varies from year to year (Forsman et al. 1984, Mazur et al. 2000, Rosenberg et al.
4833 2003, Forsman et al. 2011).

4834 The literature suggests that Barred Owls are displacing Northern Spotted Owls from their territories, and
4835 Spotted Owls are forced into lower quality breeding and foraging habitat (USFWS 2013, Sovern et
4836 al. 2014). In addition, detecting Spotted Owls during surveys is likely hindered because Spotted Owls
4837 vocalize less often when Barred Owls are nearby (Crozier et al. 2006). Displacement and reduced
4838 vocalizations are thought to negatively impact Spotted Owl productivity (Forsman et al. 2011). As
4839 discussed previously, Barred Owls are prey generalists and Spotted Owls are prey specialists; a factor
4840 that may play into reproductive success (USFWS 2013).

4841 Barred Owls are aggressive toward Spotted Owls, and have attacked Spotted Owls on occasion.
4842 Courtney et al. (2004) reported several instances where Spotted Owls were attacked by Barred Owls,
4843 and where surveyors were attacked by Barred Owls while playing Spotted Owl calls. Leskiw and
4844 Gutiérrez (1998) suspected that a Barred Owl killed and partially consumed a Spotted Owl. Johnston
4845 (2002, as cited by Courtney et al. 2004) presented evidence that a Barred Owl likely killed a juvenile
4846 Spotted Owl. It is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities
4847 were due to territorial aggression (USFWS 2013). By comparison, instances reported of Spotted Owl
4848 aggression toward Barred Owls are few (George and Lechleitner 1999, A. Ellingson, pers. comm, P.
4849 Loschl, pers. comm as cited in Courtney et al. 2004).

4850 Lewicki et al. (2015) sampled blood from Northern Spotted Owls and western Barred Owls throughout
4851 Siskiyou, Trinity, Humboldt, and Mendocino counties in an attempt to evaluate parasite dynamics and
4852 the related impacts of Barred Owl range expansion on spotted owls. Specific results related to parasite
4853 prevalence are noted within the Disease section of this report below. The study suggests that parasite
4854 dynamics in Northern Spotted Owls are not solely influenced by the presence or absence of Barred

Comment [ABF101]: See also Van Lanen, N. J., A. B. Franklin, K. P. Huyvaert, R. F. Reiser II, and P. C. Carlson. 2011. Who hits and hoots at whom? Potential for interference competition between barred and northern spotted owls. *Biological Conservation* 144:2194-2201. This experimental study was conducted in northwestern California.

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4855 Owls, but that more research is needed to assess roles of additional factors relating invasion to
4856 host/parasite dynamics (Lewicki et al. 2015).

4857 The literature suggests that Barred Owls have impacted Northern Spotted Owls in a variety of ways,
4858 including reduced survival and occupancy, displacement, reduced detection rates, and predation. In the
4859 northern portion of the Northern Spotted Owl range, where Barred Owls have existed longer and are
4860 more densely distributed, the realized negative impacts are severe. In California, where Barred Owl
4861 occurrences are relatively recent, the negative impacts are less severe at this point. However, in
4862 portions of the northern California range where Barred Owls have become more common in recent
4863 years, impacts to Northern Spotted Owls, including displacement and declines in occupancy and survival
4864 rates, have been observed.

4865 Disease

4866 The 2011 Revised Recovery Plan (USFWS 2011a) states, “It is unknown whether avian diseases such as
4867 West Nile virus (WNV), avian flu, or avian malaria... will significantly affect Spotted Owls.” Likewise,
4868 disease occurrence in Spotted Owls is likely under-reported because Spotted Owls tend to inhabit
4869 remote areas and, therefore, there is a small likelihood of carcass recovery for testing (K. Rogers,
4870 personal communication, September 25, 2014).

4871 In California, two studies have investigated the prevalence of WNV in raptor populations (Hull et al.
4872 2006, Hull et al. 2010). In migrating and wintering hawks, Hull et al. (2006) found of the 271 red-tailed
4873 hawks, 19 red-shouldered hawks, and 30 Cooper’s hawks tested, WNV antibodies were present in 5-58
4874 percent. However, no individuals that tested positive demonstrated any visible signs of illness.
4875 Conversely, WNV antibodies were not detected in 62 Northern goshawks, 209 Spotted Owls, and 22
4876 great gray owls sampled in the Sierra Nevada, suggesting low prevalence or high mortality in these
4877 species (Hull et al. 2010). Only one recent case of WNV infection was reported in a dead California
4878 Spotted Owl in 2013 from the Sierra Nevada (K. Rogers, personal communication, September 25, 2014).

4879 Research conducted elsewhere in North America, suggests WNV infection causes morbidity and
4880 mortality in several species of raptors. In Colorado, WNV infection was highest in red-tailed hawks and
4881 great-horned owls (compared to other raptor species) admitted to wildlife rehabilitation centers; clinical
4882 signs were variable and included emaciation, weakness, and inability to perch, fly, or stand (Saito et al.
4883 2007). Additionally, 40 of 56 dead raptors, evaluated for WNV, were positive; histological lesions most
4884 often included encephalitis and myocarditis (Saito et al. 2007). In Georgia, 40 out of 346 raptors tested
4885 for WNV were positive, including 4 Barred Owls, one great horned owl, and four eastern screech owls
4886 (Ellis et al. 2007). All 40 cases occurred during summer and late fall (Ellis et al. 2007), when mosquito
4887 activity is most common. Gancz et al. (2004) investigated an outbreak of WNV in several species of
4888 captive owls in Ontario, Canada, including one Spotted Owl and eight Barred Owls. Owl species with
4889 more northerly breeding ranges (e.g., snowy owl, great gray owl) showed higher rates of infection than
4890 more southerly breeding species (e.g., barn owl, eastern screech owl) (Gancz et al. 2004). WNV infection
4891 in these captive birds was found to coincide with a summer louse fly infestation, suggesting bites from
4892 the louse flies aided in WNV transmission (Gancz et al. 2004). Additionally, there is evidence that raptors

Comment [ABF102]: This sentence was confusing at first to understand. I would reword it to indicate that lack of WNV antibodies means either WNV has a low prevalence or that it causes such high mortality that birds with antibodies are never detected because infected individuals all died

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4893 can become infected with WNV after feeding on infected prey (Nemeth et al 2006). WNV infection is
4894 routinely identified in squirrels (Family: Sciuridae) (Padgett et al. 2007), as well as jays and other
4895 songbirds (Hull et al. 2010; Wheeler et al. 2009) in California; the range of these species may overlap
4896 with that of Northern Spotted Owls, possibly posing an additional infection risk.

4897 Other diseases that may impact Spotted Owls are largely unknown at this time. There are no known
4898 studies or cases of mortality caused by avian (flu) influenza in Spotted Owls. According to Rogers pers
4899 comm. (2014), prevalence of avian influenza in the spotted population is expected to be low since the
4900 disease is primarily carried by waterfowl and shorebirds, two groups that have low interaction with
4901 Spotted Owls. In addition, little information is available on the prevalence of avian malaria or
4902 Leucocytozoonosis (both blood parasites) in Spotted Owls. Significant mortality due to avian malaria or
4903 Leucocytozoonosis is rarely reported in avian species (K. Rogers, personal communication, September
4904 25, 2014), with the exception of island endemics or birds in captive situations and most infected birds
4905 seem to recover or may have chronic infections. Impacts of parasitic infection to Northern Spotted Owl
4906 survival are also unknown. However, Martinez et al. (2010), documented lowered survival of wild-
4907 breeding female blue tits (*Cyanistes caeruleus*) in Spain infected with *Haemoproteus* parasites
4908 (*Haemoproteus* and *Leucocytozoon* spp.).

Comment [ABF103]: But this is somewhat contradicted in the next paragraph.

4909 There are a handful of studies that have documented blood and intestinal parasites in owl species. Ishak
4910 et al. (2008) tested 111 Spotted Owls, and 44 Barred Owls, and 387 owls of nine other species for
4911 Leucocytozoon, Plasmodium, and Haemoproteus spp. (haemosporidian blood parasites). The study
4912 found both California and Northern Spotted Owls carried the greatest number of Leucocytozoon
4913 parasite lineages, California Spotted Owls had a higher prevalence of infection with more multiple
4914 infections than Northern Spotted Owl, and Barred Owls along the coast had lower rate of infection
4915 (15%) than Northern Spotted Owls (52%) and California Spotted Owls (79%). They suggested that the
4916 greater infection load of Spotted Owls compared to Barred Owls may favor the later in competitive
4917 interactions. Interestingly, Ishak et al (2008) documented the first ever case of Plasmodium infection in a
4918 Northern Spotted Owl. Gutiérrez (1989) tested 105 Spotted Owls (seven populations and all subspecies)
4919 for hematozoa (a blood parasite) and found all to be infected with at least one hematozoan. This study
4920 suggested that the owls large home range, spanning various forest types, the time spent caring for and
4921 provisioning young, and their long life span make this species more susceptible to higher rate of
4922 infection compared to other bird species (Gutiérrez1989). From 2008 to 2012 blood samples were
4923 analyzed from Northern Spotted Owls (n=98) and western Barred Owls (n=49) throughout Siskiyou,
4924 Trinity, Humboldt, and Mendocino counties and tested for blood parasite loads (Lewicki et al. 2015). For
4925 comparison, blood samples were also analyzed from eastern Barred Owls (n=135) housed in wildlife
4926 rehabilitation centers throughout their historic range. Lewicki et al. (2015) found *Haemoproteus* spp.
4927 infection prevalence higher in Northern Spotted Owl (76.5%) than western Barred Owl (30.6%), and
4928 highest in eastern Barred Owl (88.1%), and infection intensity was nearly 100 times greater in Northern
4929 Spotted Owl than western Barred Owl. The study did not directly evaluate the impacts of blood parasite
4930 infections on the owl species assessed (Lewicki et al. 2015).

Comment [ABF104]: But coupled with the other studies below, Plasmodium is probably very rare in northern spotted owls in California

Comment [ABF105]: Could also present the results of key hypotheses tested in this study

4931 In Oregon, Hoberg et al. (1993) reported enteric coccidia (intestinal parasite) in a juvenile female
4932 Northern Spotted Owl. The presence of the parasite did not appear to contribute to the juvenile Spotted

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Owl's death; however, death has been attributed to this type of parasite in other raptor species (Hoberg et al. 1993). In this case study, transmission was thought to be through consumption of infected small mammal prey (e.g., mice, squirrels, woodrats). Trichomonosis is a concern for Spotted Owls if they consume Columbids infected with the protozoan parasite, *Trichomonas gallinae*, where species ranges overlap. The Department's Wildlife Investigation Lab documented two cases of Trichomonosis in California Spotted Owl in 2012, two cases in Northern Spotted Owl in 2014 from the Coastal Mountain Range, north of San Francisco Bay, and one in a great gray owl in 2006 and in 2007 (K. Rogers, personal communication, September 25, 2014).

In northwestern California, Young et al. (1993) found Hippoboscids flies on 62 of the 382 Northern Spotted Owls captured over five years between April and September, with higher prevalence in adults than juveniles. The flies were more abundant in years when fall temperatures were high, winter precipitation were low, and summer temperatures were low, suggesting fly abundance is climate dependent. Consequently, the frequency of Hippoboscids flies in the Northern Spotted Owls population may vary in intensity as climate changes (Young et al. 1993).

To address the shortfall of information on disease impacts to Spotted Owls, Recovery Action 17 of the 2011 Recovery Plan is, "Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, Plasmodium spp.) and address as necessary" (USFWS 2011a). In addition, the Department's Wildlife Investigation Lab is currently conducting a raptor disease and contaminant surveillance study that will help determine disease occurrence and contaminant exposure in raptor populations statewide, including both Northern and California Spotted Owls. This study will include targeted surveillance for a wide array of diseases and contaminants such as, WNV, mange, Avian Trichomonosis, Avian Chlamydiosis, and Avian Herpesvirus, AR and lead poisoning.

Contaminants

Northern Spotted Owls feed on a variety of prey species, but mainly small mammals make up a bulk of their diet. Consequently, the main contaminant threat to the owls is anticoagulant rodenticide poisoning. The anticoagulant rodenticides (ARs) are grouped into first-generation compounds (diphacinone, chlorophacinone and warfarin), requiring several doses to target species before death occurs, and second-generation ARs (SGARs; e.g., bromadiolone, brodifacoum, difenacoum and difethalone), requiring only a single dose. Second generation ARs are more acutely toxic and persist in tissues and in the environment (Gabriel et al. 2013).

Numerous field monitoring studies on other raptor and owl species indicate lethal and sublethal impacts of AR exposure (Mendenhall and Pank 1980, Stone et al. 2003, Walker et al. 2008, Albert et al. 2009, Murray 2011, Thomas et al. 2011, Christensen et al. 2012, Sánchez-Barbudo et al. 2012). In California, Lima and Salmon (2010) analyzed tissues from 96 raptors of 10 species brought to wildlife rehabilitation centers in San Diego and the Central Valley, and found that 69% (Central Valley) to 92% (San Diego) had been exposed to anticoagulant rodenticides. In Massachusetts, Murray (2011) tested 161 wild Red-tailed Hawks, Barred Owls, Eastern Screech Owls (*Megascops asio*), and Great Horned Owls and found 86 percent with ARs in liver tissue, of which 99 percent was brodifacoum, a SGAR. Another study in New

Comment [ABF106]: I would couch this in terms of secondary poisoning

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4971 York found ARs present in 49 percent of wild raptors tested (n=265; 12 species), most prevalent in Great
4972 Horned Owls (43/53; 81%) and less prevalent in Barred Owls (3/13; 23%), with SGARs (brodifacoum and
4973 bromadiolone) being the most frequently detected (Stone et al. 2003). Nine of the 53 Great Horned
4974 Owls and one of the 13 Barred Owls died in this study, revealing a mortality rate of 17 percent and 8
4975 percent, respectively (Stone et al. 2003).

4976 In addition to the field monitoring that demonstrates widespread exposure of raptor/owl species to ARs,
4977 investigations of wildlife mortality incidents show that raptors comprise two-thirds of the anticoagulant-
4978 related wildlife mortalities (Department's Wildlife Investigation Lab files). These incidents are most likely
4979 to be reported in more populated areas, but it is reasonable to assume that any area where ARs are
4980 used for outdoor rodent control would share a similar pattern. The Department's Wildlife Investigation
4981 Lab documented several recent cases of AR poisoning for the California Spotted Owl (K. Rogers, personal
4982 communication, September 25, 2014); two cases in 2013, and two in 2014. However, at this time it is
4983 unknown how widespread morbidity and mortality is for the spotted owl population in California. As
4984 mentioned above, the Wildlife Investigation Lab is currently conducting a statewide raptor disease and
4985 contaminant surveillance study that will target AR occurrence in raptor populations to help shed light on
4986 the extent of this threat.

4987 Few laboratory studies have been conducted that test impacts of ARs on raptors, and no known studies
4988 have evaluated impacts on spotted owls. In a laboratory study by Mendenhall and Pank (1980), three
4989 species of captive owls fed mice or rats killed with the ARs bromadiolone, brodifacoum, or diphacinone
4990 (SGARs) died of hemorrhaging, those fed mice or rats killed with difenacoum (SGAR) displayed sublethal
4991 hemorrhaging, and those fed mice or rats killed with fumarin or chlorophacinone (1st generation ARs)
4992 displayed no signs of illness. Eastern Screech Owls were fed diphacinone for 7 days in a laboratory
4993 setting and monitored for 21-days post exposure (Rattner et al. 2013). This study found that toxicity
4994 appeared quickly upon exposure to lethal levels, but returned rapidly to normal in most owls after
4995 exposure was terminated (Rattner et al. 2013).

4996 Bond et al. (2013), notes the use of rodenticides (prevents damage to young trees from rodents
4997 browsing) or herbicides (suppresses shrubs to allow growth of trees) in burned forests and the potential
4998 threat of these substances to Spotted Owls. The use of herbicides and rodenticides may reduce the prey
4999 habitat and abundance for Spotted Owls, however it is unlikely the activity would be a major source of
5000 rodenticide exposure for owls because the type of poison used are generally 1st generation
5001 anticoagulant rodenticides, which are not as persistent or toxic in their target species (S. McMillin,
5002 personal communication, September 25, 2014).

5003 In illegal marijuana grows, widespread in the Northern Spotted Owl range, growers typically apply
5004 second generation AR at the base of plants to prevent small mammals from damaging the crop
5005 (Thompson et al. 2013, Gabriel et al 2013). These 2nd generation rodenticides present a risk to predators
5006 of small mammals, such as the Northern Spotted Owl, because this type of rodenticide is more acutely
5007 toxic, and persists in tissues and in the environment (Gabriel et al. 2013).

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The fisher is a species whose range and prey base overlaps with the Northern Spotted Owl (Zielinski et al. 1999, Zielinski et al. 2004), thus, the impacts of rodenticides in fisher may also be an impact to Northern Spotted Owl. Thompson et al. (2013) studied impacts of ARs to fishers in the southern Sierra Nevada and found impacts of ARs in association with illegal marijuana grows significant. Toxicants found at grow sites within the study area included brodifacoum and bromadiolone (SGARs), carbofuran (a pesticide currently banned in the United States), and malathion (an insecticide). Thirty-nine out of 46 fisher carcasses recovered (88%) tested positive for one of more AR compound with brodifacoum being the most common (Thompson et al. 2013). Another fisher study in California's Sierra Nevada found 79 percent of fisher carcasses (n=58) tested were exposed to ARs, and of that, 96 percent were exposed to SGAR compounds (Gabriel et al. 2013). Given these results, and the presumed extent of illegal marijuana grows in California (Gabriel et al. 2013, Thompson et al. 2013), it is likely that exposure to AR prevalence is widespread and is impacting Northern Spotted Owls in California to some extent. However, the effects and prevalence of poisoning events on overall fitness (e.g., survival and fecundity) remains unknown.

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytophthora ramorum*) which infects a variety of species. It is particularly lethal to tanoaks (*Lithocarpus densiflorus*) and several species of true oaks (*Quercus* spp.). In other species it may cause dead bark, leaf blight, and twig dieback (Shaw 2007, USFWS 2011a), and some hosts may be asymptomatic. Nearly all tree species in mixed evergreen and redwood-tanoak forest types may be hosts (Davidson et al. 2003, Garbelotto et al. 2003). According to Goheen et al. (2006),

"The pathogen has a wide host range including Douglas-fir, grand fir, coast redwood, and many other tree and shrub species common in Oregon and Washington forests. Tree mortality, branch and shoot dieback, and leaf spots result from infection depending on host species and location. *Phytophthora ramorum* spreads aerially by wind and wind-driven rain and moves within forest canopies and tree tops to stems and shrubs and from understory shrubs to overstory trees. The pathogen survives in infected plant material, litter, soil, and water. It is moved long distances in nursery stock... State and Federal personnel regularly survey forests and nurseries in the Pacific Northwest to detect the disease."

In 1995, sudden oak death was discovered in California within Mill Valley (Marin County), and has since spread across multiple coastal counties impacting coastal live oaks and tanoak forests within (Tietje et al. 2005). According to recent submission to the GIS tool "OakMapper", confirmed locations of *P. ramorum* in California range from the coastal ranges in Monterey County and north up through portions of Humboldt County (California Oak Mortality Task Force 2015). Many studies have documented the widespread damage and mortality of oak-tanoaks coastal woodlands from Humboldt to Monterey counties (Rizzo and Garbelotto 2003, McPherson et al. 2005, Goheen et al. 2006, Cobb et al. 2009, Cobb et al. 2012). Shaw (2007) indicated that the disease in California is likely linked to coastal climates that are typically warmer and wetter than more inland forest types. There is large-scale concern regarding the impacts of this disease on forest structure and composition in California, and the associated impacts to wildlife species that inhabit these forests.

Comment [A107]: Note to external reviewers: A publication is in the works to assess the potential impacts of ARs associated with marijuana plants to spotted owls, using barred owls as a surrogate. An abstract regarding this work, noted that the study found 40% of all Barred Owls tested were exposed to ARs in suitable NSO habitat within managed timberland in NW CA. The full analysis and result write-up are underway. Information from this effort will likely inform us on exposure to and impacts of ARs to owl fitness. This information will have to be added after external review, assuming it is ready prior to submission of this report to the Fish and Game Commission.

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5047 Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases
5048 quickly. Cobb et al. (2009) examined mortality caused by sudden oak death within coastal redwood
5049 forests from Sonoma to Monterey counties. Tanoaks confirmed to be infected died on average within 1-
5050 6 years, and larger trees that were close to other infected species, such as the California bay laurel
5051 (*Umbellularia californica*), were infected to a greater extent than smaller, more remote trees. Tanoaks
5052 survived longer within redwood and Douglas-fir dominated forests than in hardwood dominated stands
5053 (Cobb et al. 2009). In Marin County, McPherson et al. (2010) examined the survival of coast live oaks,
5054 black oaks (*Q. kelloggii*) and tanoaks once infected by sudden oak death. The study found that live oak
5055 and tanoak survival declined as a function of disease state. Coast live oak survival was 11.7 to 15.8 years
5056 for asymptomatic trees; 7.5 to 11.7 years for trees bleeding only; and 2.6 to 3.4 years for trees bleeding
5057 with ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010). Tanoak survival was 8.8
5058 years for asymptomatic trees; 5.9 years for trees bleeding only; and 1.7 years for trees bleeding with
5059 ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010).

5060 After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi
5061 and insects is common and impacts survival times. For example, McPherson et al. (2005) found
5062 symptomatic progression and eventual mortality of coast live oaks and black oaks due to sudden oak
5063 death followed a similar sequence: bleeding, beetle colonization, emergence of *Hyposylon thouarsianum*
5064 (another fungal infection), and then death. Here, approximately 50% of bleeding live oaks were infected
5065 by ambrosia beetles and bark beetles, or showed evidence of past beetle infestation, whereas beetles
5066 infested tanoaks with less frequency (McPherson et al. 2005).

5067 It is unlikely that the impact of sudden oak death on oak-tanoak forests will subside in the future. Brown
5068 and Allen-Diaz (2005) examined past, current and future changes of coast live oaks-bay laurel woodland
5069 structure and composition within the San Francisco Bay Area due to sudden oak death infections. There
5070 was a 2-27% loss of coast live oak basal area (m²/ha) during the study period (2002-2004), a 4-55% loss
5071 in the recent past (5-10 years prior to 2002) through 2004, and a projected 15-69% coast live oak basal
5072 area loss in the future, with a total stand basal area was predicted to decrease up to 42% within the next
5073 5 years (Brown and Allen-Diaz 2005). Meentemeyer et al. (2009) predicted that with no control
5074 measures, sudden oak death will increase by 10-fold by 2030, particularly along the coast north of San
5075 Francisco. The model suggests that wet weather conditions exacerbated by predicted change climate
5076 regimes serve to double the rate of spread in California (Meentemeyer et al. 2009). Predictive models
5077 note forests at high risk to sudden oak death in California occur in coastal forests of Santa Barbara
5078 County north through Humboldt County (Koch and Smith 2012).

5079 Oak-tanoak forests are present within the Northern Spotted Owl range in California and are an
5080 important component to owl habitat (see Habitat Section of this report). Oak and tanoak forest types
5081 and as elements within conifer forest provide habitat for the owl's main prey base, the dusky-footed
5082 woodrat, as well as other small mammals that comprise a smaller component of the owl's diet. There
5083 are no known published work evaluating the wildlife consequences of sudden oak death focus on
5084 impacts to Northern Spotted Owl habitat; however, results from these studies may inform potential or
5085 likely impacts of sudden oak death the species given what we know about owl habitat and prey needs.

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Within an infected study site in on Marin County, Temple and Tietje (2005) found coarse woody debris, a habitat component important for many small mammals, was 70 times higher than on an uninfected plot in Sonoma County, a difference supposedly due to sudden oak death-induced coarse woody debris generation. Within San Luis Obispo County, an area where sudden oak death has a low prevalence, areas in “high-risk” woodlands (i.e., those with species composition thought to be most impacted by sudden oak death) small mammals, including the dusky-footed woodrat, were more abundant (Temple et al. 2005, Temple and Tietje 2005). The difference in species abundance between the sites is likely inherent, the authors’ link to sudden oak death impacts of the comparison is unclear. However, these studies speculate that California bay laurel may replace coast live oak trees in the forest canopy. While having ecological importance, California bay laurel is relatively less productive than oaks as a wildlife habitat component.

Only one study has provided any direct link to Spotted Owl occupancy and habitat impacts due to sudden oak death. Within Big Sur forests of California, Holland et al. (2009) indicated that California Spotted Owl were more likely to occur in forests with greater amount of tree mortality, suggesting sudden oak death could benefit owls in the short-term by generating coarse woody debris (e.g., downed logs and branches), key habitat features for the owl’s prey resources. However, over the long-term, coarse woody debris and snags will decay and the supply will diminish thus prey resources may decrease and thereby impacting habitat suitability for the owls.

More generally, several studies indicate an impact on small mammal populations associated with sudden oak death infestations within coastal forests, but do not provide a link between Spotted Owl occupancy. Several studies suggested that that woodrats and mice (*Peromyscus* spp.) may benefit from immediate changes in habitat features (e.g., increase in coarse woody debris, increased shrub cover) within infected areas; however long-term abundance is less certain in the face of continued sudden oak death infection (Apigian et al. 2005, Temple and Tietje 2005).

The 2011 Northern Spotted Owl Recovery Plan (USFWS 2011a) notes this disease as a potential threat “due to its potential impact on forest dynamics and alteration of key prey and Spotted Owl habitat components (e.g., hardwood trees, canopy closure, and nest tree mortality)... especially in the southern portion of the Spotted Owl’s range (Courtney et al. 2004).” However, the USFWS (2011a) asserted that the extent of the impact of sudden oak death to owl habitat, prey species, and occupancy has not been thoroughly assessed. To address the shortfall of information, Recovery Action 17 of the 2011 Recovery Plan is to “Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, *Plasmodium* spp.) and address as necessary” (USFWS 2011a). Monitoring techniques have been developed and may consist of regular aerial and ground surveys to assess rate of sudden oak death infection within oak-tanoak forest communities (Mai et al. 2005). However, such monitoring will detect spread well after a local invasion is established. Early detection techniques, such as eDNA sampling, may allow quicker intervention, but the efficacy of the various methods (Cobb et al 2013) still needs thorough evaluation.

Predation

The 2011 Revised Recovery Plan (USFWS 2011a) states,

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5124 “Known predators of Spotted Owls are limited to great horned owls (Forsman et al. 1984), and,
5125 possibly, barred owls (Leskiw and Gutiérrez 1998). Other suspected predators include northern
5126 goshawks, red-tailed hawks, and other raptors (Courtney et al.2004). Occasional predation of
5127 Spotted Owls by these raptors is not considered to be a threat to Spotted Owl populations, so
5128 no criteria or actions are identified.”

5129 No new information has been generated since this statement was made, and therefore, the threat of
5130 predation to Northern Spotted Owls remains negligible.

5131 **Recreational Activities**

5132 Natural stress events (predator interactions, precipitous weather, disease, care of young), or
5133 anthropogenic stress events (vehicle traffic and noise, hikers) can impact species on multiple levels. This
5134 may include physiological impacts such as suppressed reproduction and growth (REFS), or behavioral
5135 responses such as avoidance (e.g., vocalizations and flushing).

5136 Collecting and analyzing fecal samples has been shown to be effective at detecting stress hormone
5137 production (e.g., glucocorticoids) in owls (Wasser and Hunt 2005). By employing this methodology, a
5138 study conducted in the Shasta Trinity and Mendocino National Forests, California, found Northern
5139 Spotted Owls exhibit more stress when exposed to motorcycle activities, and exhibit lower reproductive
5140 success when exposed to busy roads (Hayward et al. 2014). Wasser et al. (1997) collected fecal samples
5141 from wild Northern Spotted Owl in Washington to measures stress hormone production in relation to
5142 timber activities (e.g., logging roads timber management). Males showed a more prominent increase in
5143 corticosterone production when the disturbance occurred with 0.41 km (0.25 miles) of the home range
5144 center, and in males whose home ranges were close to clear-cut (vs. selective logging).

5145 Presence of hikers has been shown to alter owl behavior at roosting and nesting sites. Swarthout and
5146 Steidl (2001) found that juvenile and adult Mexican Spotted Owls were less likely to flush from the
5147 presence of a hiker at 212 and 224 meters, respectively, and neither juveniles nor adults were likely to
5148 alter behavior at distances 255 meter or more. At nesting territories, Mexican Spotted Owls in Utah
5149 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance
5150 with the presence of hikers (Swarthout and Steidl 2003).

5151 It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the
5152 level to which these activities may impact owl behavior, reproduction and overall survival has yet to be
5153 determined. It is unlikely anthropogenic stress events associated with recreation will impact Northern
5154 Spotted Owl reproduction and survival to any great extent, though further research is warranted.

5155 **Loss of Genetic Variation**

5156 There had previously been little evidence in the literature of loss of genetic variation and population
5157 bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across
5158 the range of the Northern Spotted Owl provides compelling evidence that a population bottleneck may
5159 have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from

Comment [ABF108]: See also:
1. Tempel, D. J., and R. J. Gutiérrez. 2003. Fecal corticosterone levels in California spotted owls exposed to low-intensity chainsaw sound. Wildlife Society Bulletin 31:698-702.
2. Tempel, D. J., and R. J. Gutiérrez. 2004. Factors Related to Fecal Corticosterone Levels in California Spotted Owls: Implications for Assessing Chronic Stress. Conservation Biology 18:538-547.

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5160 352 Northern Spotted Owls from six regions across the range which included limited samples from the
5161 northern portion of the California Klamath Province.

5162 Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades)
5163 bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant
5164 evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest
5165 California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic
5166 variation and hence effective population size, do not necessarily indicate a decline in actual
5167 (demographic) population size (Funk et al. 2010) "... it is important to keep in mind that
5168 reductions in [effective population size] (detected with bottleneck tests) are different than
5169 reductions in demographic population size (detected with demographic field studies) and
5170 reductions in one of these parameters does not necessarily result in a change in the other."
5171 (Funk et al. 2010)

5172 The scientific review of the Draft Recovery Plan Recovery was able to review unpublished genetic
5173 studies from Dr. Susan Haig (Courtney et al. 2008). Using samples collected from 352 owls, the results
5174 provided some evidence that recent bottlenecks have occurred at various spatial scales within the
5175 Northern Spotted Owl range, but could not definitively link the genetic declines to recent population
5176 declines (USFWS 2011a, Courtney et al. 2008). Genetic scientists reviewing Haig's work concluded that
5177 the bottlenecks observed by Haig were likely the result of recent population declines rather than the
5178 cause of decline (Courtney et al. 2008). Specifically, Courtney et al. (2008) states,

5179 "The conclusion by Barrowclough and Coats (1985) is still appropriate here, which is that the
5180 population dynamics of the Spotted Owl likely will be more important to its short-term survival
5181 than will be its genetic makeup, regardless of the evidence for bottlenecks having occurred in
5182 the past. Our conclusions might warrant re-consideration at some future point, in the context of
5183 explicit evidence linking reductions in genetic diversity to current conditions, and current or
5184 future population performance. "

5185 **Summary of Listing Factors**

5186
5187 The California Endangered Species Act directs the Department to prepare this report regarding the
5188 status of the Northern Spotted Owl in California based upon the best scientific and other information
5189 available to the Department (Fish & G. Code, § 2074.6, subd. (a); Cal. Code Regs., tit. 14, § 670.1, subd.
5190 (f)). CESA's implementing regulations identify key factors that are relevant to the Department's analyses.
5191 Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that
5192 its continued existence is in serious danger or is threatened by any one or any combination of the
5193 following factors: (1) present or threatened modification or destruction of its habitat; (2)
5194 overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-
5195 related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

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5196 The definitions of endangered and threatened species in the Fish and Game Code guide the
5197 Department’s scientific determination. An endangered species under CESA is one “which is in serious
5198 danger of becoming extinct throughout all, or a significant portion, of its range due to one or more
5199 causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or
5200 disease.” (Fish & G. Code, § 2062). A threatened species under CESA is one “that, although not presently
5201 threatened with extinction, is likely to become an endangered species in the foreseeable future in the
5202 absence of special protection and management efforts required by [CESA].” (*Id.*, § 2067).

5203 The Department’s summary of listing factors are summarized below:

5204 **Present or threatened modification or destruction of habitat**

5205 *Timber Harvest and Regulatory Considerations*

5206 Although the rate of nesting and roosting habitat loss has declined since the Northern Spotted Owl was
5207 listed under the federal endangered species act in 1990, assessments performed on rangewide since the
5208 implementation of the NWFP show that habitat loss is ongoing. Wildfire and other natural disturbance
5209 has been the leading cause of habitat loss on federal land and timber harvest has been the leading cause
5210 of habitat loss on nonfederal lands since 1994. Although state regulations governing timber harvest on
5211 nonfederal lands in California (i.e., California Forest Practice Rules) are the most protective state
5212 regulations in the range of the Northern Spotted Owl, losses of nesting and roosting habitat due to
5213 timber harvest in California have continued. Since 1994, 5.8% of nesting and roosting habitat on
5214 nonfederal lands in California has been removed by timber harvest.

5215 California Forest Practice Rules

5216 Minimum habitat retention requirements are identified in the Forest Practice Rules for timber harvest
5217 occurring on privately owned land in California. Definitions for the different habitat types to be retained
5218 are also included in Forest Practice Rules. Habitat Retention requirements and definitions were
5219 developed in the early 1990s and can be found in Table 20 and Appendix 2. Retention requirements
5220 were established for a combination of nesting, roosting, and foraging habitat in the area immediately
5221 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the
5222 broader home range (1.3 mile radius).

5223 The most recent research on Northern Spotted Owl habitat requirements in California and southern
5224 Oregon have demonstrated a link between owl fitness and the amount of types of habitat, structural
5225 characteristics, and spatial configuration in a home range. This requirement for habitat heterogeneity is
5226 consistent with the general approach incorporated in the Forest Practice Rules. Although study design
5227 has varied across the major research studies, some consistent patterns have arisen. In order to support
5228 productive Spotted Owl territories, a minimum amount of older forest must be retained in the core
5229 area. The definition of ‘older forest’ evaluated in studies has varied, but consistently includes late-seral
5230 forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older
5231 forest in an approximately 400 acre core area.

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5232 Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling
5233 cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness.
5234 Results indicate that in order to support a productive Northern Spotted Owl territory, no more than
5235 about 50% of a home range should consist of nonhabitat.

5236 The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations
5237 for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest
5238 Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls. The total acreage of
5239 recommended retention in the USFWS guidance does not differ from that found in the Forest Practice
5240 Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range
5241 must be retained in habitat. However, based on assessment of core use areas in the interior portion of
5242 the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an
5243 activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations
5244 in line with core use areas evaluated in recent work. The most significant change in the revised USFWS
5245 recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific
5246 amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for
5247 nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained
5248 near the core is consistent with the literature.

5249 A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised
5250 USFWS recommendations (see Table 22 for the interior portion of range in California) shows large
5251 discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under
5252 the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the
5253 USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
5254 This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500
5255 acres spotted owl habitat to be retained within 0.7 miles and the total of 1,336 acres to be retained
5256 within 1.3 miles of an activity center can be composed of functional foraging habitat under Forest
5257 Practice Rules, a definition that is considered low quality foraging habitat by the USFWS; therefore there
5258 is no requirement in the Forest Practice Rules for this habitat include nesting or roosting habitat under
5259 the Forest Practice Rules.

5260 Our assessment of selected activity centers shows that the habitat retention guidance in the Forest
5261 Practice Rules are not always met, indicating that harvest is impacting Northern Spotted Owl at some
5262 locations. Of the activity centers evaluated, several experienced very high acreages of harvest at both
5263 the broad home range and in the core area, which would have resulted in territories that do not meet
5264 the USFWS recommendation for take avoidance, and would have resulted in declines in survival and
5265 fitness of the local owls.

5266 Documentation of habitat type, amount, and distribution present around activity centers after THPs are
5267 implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the
5268 Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if
5269 minimum retention requirements in the Forest Practice Rules are implemented as written, there is still
5270 the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated

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5271 failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts
5272 that have occurred in recent years.

5273 The THP review and post-harvest follow-up process should ensure that the best scientific information is
5274 being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to
5275 which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a
5276 sample of activity centers indicates that it is not universally applied and that insufficient habitat has
5277 been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern
5278 Spotted Owl is likely to continue experiencing loss of habitat in California.

5279 Salvage Logging

5280 Several variables complicate the interpretation of owl response to fire, including variation in fire
5281 severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing
5282 and duration of research post-fire. Regardless, several studies have suggested that salvage logging after
5283 a fire or occurrence of extensive high severity burns likely have contributed to a decline in habitat use,
5284 occupancy, or survival of Northern Spotted Owls. Although hampered by small sample size, incidental
5285 observations have documented declines in occupancy of burned areas following salvage logging.
5286 Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction
5287 probabilities, although the impacts of salvage logging were observed only in combination with other
5288 factors.

5289 The presence of snags has been suggested as an important component of prey habitat and as perch sites
5290 for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub
5291 and herbaceous cover and number of snags, may be impacted by salvage logging.

5292 Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the
5293 fire itself, by removing important structural elements and removing important prey habitat. The
5294 available information suggests that salvage logging reduces the probability that spotted owls will use
5295 burned areas and has resulted in declines in occupancy, either through abandonment or declines in
5296 survival.

5297 *Wildfire*

5298 Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and
5299 wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994,
5300 after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to
5301 wildfire, and most of this loss has occurred in the Klamath Province.

5302 The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to
5303 use burned areas extensively, although nesting and roosting general occurred only in unburned or low-
5304 severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by
5305 California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in

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5306 burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some
5307 evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

5308 Conversely, Northern Spotted Owls in southern Oregon were shown to have declines in occupancy
5309 following fire. These declines resulted from both high extinction rates in burned areas and low
5310 colonization rates.

5311 Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to
5312 experience declines in survival. Food limitation in burned areas may have been a factor in declining
5313 survival rates. These observed declines in southern Oregon may be confounded by the occurrence of
5314 post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl
5315 subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in
5316 the year following fire; these owls were not tracked to investigate potential longer-term effects.

5317 Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or
5318 areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance
5319 for foraging.

5320 The available information suggests that wildfires can have positive effects on Northern Spotted Owls
5321 when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without
5322 removing important nesting and roosting habitat components at the territory scale. However,
5323 uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating
5324 required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed
5325 in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be
5326 used as a management tool.

5327 Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California
5328 included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades,
5329 fires have become more frequent and average fire size has increased. In some cases fires have also
5330 burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry
5331 and hot conditions). Because climate change will likely increase the likelihood of conditions that support
5332 fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

5333 Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue
5334 experiencing loss of habitat in California.

5335 *Climate Change Impacts to Forest Composition and Structure*

5336 Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate
5337 projection scenarios specific to California, the most notable response to increase temperature was a
5338 shift from conifer-dominated forests (e.g., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g.,
5339 Douglas fir-tan oak) in the northern half of the state), expansion of conifer forests into the northeast
5340 portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine
5341 forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-

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tan oak forests, and advancement of conifer-dominated forests (e.g., redwood and closed-cone pine forests) along the north-central coast. Tree productivity along California’s north-central coastal and at high elevation forests may increase in response to increased growing season temperatures; however, reductions in summer fog in concert with increased temperatures may reduce productivity of redwood forests along the coast. In addition, the literature suggests that climate change variables will increase the severity and frequency of wildfires within the Northern Spotted Owl range.

Although climate projection models have uncertainties built-in, it is apparent from the literature that forests within California will likely experience some level of elevational and latitudinal shifts, changes in species composition, and alterations in fire regimes. For the Northern Spotted Owl, who has a heavy reliance on specific forest structure components and tree species composition, and associated prey habitat and abundance, implications of such forest shifts and fire regime changes may prove unfavorable to the species over time. During long-term landscape planning related to Northern Spotted Owls and their habitat, potential climate change impacts should be analyzed and incorporated.

Other Mechanisms of Habitat Loss

Sudden Oak Death

Sudden oak death syndrome is recognized as a potential threat to Northern Spotted Owls due to impacts on forest structure and composition, and consequently alteration of prey habitat and abundance. The disease is particularly lethal to tanoaks and several species of true oaks. Confirmed locations of sudden oak death in California range from the coastal ranges in Monterey County and north up through portions of Humboldt County. Portions of California coastal forests at a high risk of infection have been identified in Santa Barbara County north through Humboldt County.

Predictive modeling studies indicate that the disease is projected to increase 10-fold by 2030 in California, which could be exacerbated by wetter weather conditions on the coast predicted by climate change models. Given this, there is concern over the potential impact of sudden oak death in California to Northern Spotted Owls in the future. For instance, oak-tanoak forests support the dusky-footed woodrat, one of the owl’s main prey species, as well as other small mammals that comprise a smaller component of the diet. If abundance of prey is altered within the range of the Northern Spotted Owl due to decreases in oak-tanoak forests, negative impacts to owls will likely ensue.

Though no studies have yet evaluated the consequences of sudden oak death specific to Northern Spotted Owl habitat and fitness in California, there is evidence that habitat and prey abundance will be impacted in the face of this disease, and impacts will vary spatially and temporally. The literature suggests that short-term impacts may initially provide an increase in prey habitat and abundance, and thus may lead to an increased owl occupancy rate. However, this phenomenon will likely subside when habitat conditions deteriorate over time or tree species composition changes to a point the area can no longer support key owl prey species.

Comment [ABF109]: But tanoak is also an important structural component of mature forests used by spotted owls in California (see my General Comment 6 under the THREATS section)

Comment [ABF110]: I would argue that this is not an appropriate statement, based on a conference abstract (see my General Comment 6 under the THREATS section)

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5377 The extent of sudden oak death impacts to Northern Spotted Owl habitat, prey species, and occupancy
5378 needs to be thoroughly assessed. Early detection techniques should be explored and implemented
5379 within coastal California forests so that negative impacts can be realized and remediated, if possible.

5380 Marijuana Cultivation

Comment [ABF111]: Seems the most important impact is rodenticide use, which is not mentioned here or elsewhere in the Summary

5381 Illegal and legal marijuana cultivation in remote forests on public and private land throughout California
5382 has been on a steady increase. Within the range of the Northern Spotted Owl, Shasta, Tehama,
5383 Humboldt, Mendocino, and Trinity counties comprise the areas known for the most marijuana
5384 cultivation in California due to the remote and rugged nature of the land, making cultivation difficult to
5385 detect, and habitat conditions favorable for growing marijuana (e.g., wetter climate, rich soils). Given
5386 the difficulties in detecting both legal marijuana cultivation sites and the lack of reporting legal
5387 cultivation sites, actual distribution and density of marijuana cultivation is likely larger and higher than
5388 represented in datasets collected to date.

5389 Activities associated with cultivation (e.g., removal of large trees, degradation of riparian habitat) may
5390 negatively impact Northern Spotted Owl habitat, though data on the extent of this impact is not well
5391 known. Areas with higher prevalence of marijuana cultivation may also contain high numbers of
5392 Northern Spotted Owl activity centers. The level of impact likely depends on several factors, including
5393 the density of cultivation sites in proximity to owl activity centers and how much owl habitat is affected
5394 and to what extent. Given that marijuana cultivation is on the rise in California, a thorough assessment
5395 of potential habitat impacts to Northern Spotted Owls should be implemented.

5396 **Abundance and Demographic Rates**

5397 Few studies have attempted to examine range-wide Northern Spotted Owl population estimates. Survey
5398 methodology and effort does not allow for reliable estimates across the range or within California, and
5399 does not effectively sample nonterritorial floater individuals. Northern Spotted Owl densities vary
5400 across the range and forest types; therefore, extrapolating the few local estimates across the range of
5401 the subspecies would result in biased estimates of abundance. The Department's Spotted Owl Database
5402 houses a cumulative tally of all historic owl observations and activity centers, and for this reason it is
5403 inappropriate to use the Dataset as a surrogate for abundance and density estimates. The increase in
5404 number of activity centers over time is more likely the result of expanded survey effort than
5405 establishment of new activity centers. In addition, across most of the Northern Spotted Owl range
5406 establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a
5407 slow process given tree species growth rate (with a possible exception on the coastal redwood forests),
5408 and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

5409 One recent study made use of the immense amount of data available on Northern Spotted Owl habitat
5410 requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity,
5411 dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the
5412 range of the owl. In addition to an evaluation of source-sink dynamics, outcomes of the model included
5413 a range-wide population size estimate, and the proportion of the population in each modeling region

Comment [ABF112]: But see my General Comment 2 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

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5414 and physiographic province noted in the 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The
5415 study estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner
5416 California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling
5417 regions. Three provinces located in California were estimated to contain over 50 percent of the range-
5418 wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a
5419 stronghold for the population. Even though the complexity of the model may limit its ability to
5420 accurately model population estimates, the results suggest that California's population of Northern
5421 Spotted Owls is an important component of the range-wide population.

5422 Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource
5423 Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for
5424 more than two decades to assess demographic parameters such as population growth, survival,
5425 fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study
5426 areas range-wide. In California, the most recent meta-analysis covering years 1985-2008 reported a
5427 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline
5428 per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the
5429 Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation
5430 study area reported a 2.3% population decline per year through 2012. When converting estimates for
5431 population change to estimates of realized population change (i.e., the proportional change in estimated
5432 population size relative to population size in the initial year of analysis) two study areas in California
5433 (Green Diamond Resource Company and Northwest California) showed estimated population declines of
5434 about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight
5435 decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary
5436 meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across
5437 the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The
5438 ongoing analysis has revealed declines in California between 32 and 55% over the study period.

5439 In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young
5440 produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged
5441 from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green
5442 Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian
5443 Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in
5444 Washington and Oregon. Although less severe than in Washington and much of Oregon, all three
5445 California study areas show declines in survival.

5446 Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in
5447 California give us information on current estimates for reproductive success (number of young fledged
5448 per monitored site) and survival, and are consistent with a continued decline within all demographic
5449 study areas in California. In the coastal portion of the Northern Spotted Owl range in California, many
5450 areas reported consistently low reproductive success from 2011-2013, including some of the lowest
5451 reproductive success rates on record in 2013 despite weather conditions that would typically support
5452 good reproductive success. This was observed on many timber company lands, tribal lands, and National

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5453 Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In
5454 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive
5455 rate since 2009.

5456 The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study
5457 areas in California reflected trends on non-federal lands because two study areas are on non-federal
5458 lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl
5459 habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal
5460 land. However, the authors also suggest that results depict an optimistic view of the overall population
5461 status of the Northern Spotted Owl on private lands because the non-federal lands included in the
5462 demographic study areas are managed for owls. Results from the demographic study areas are thought
5463 to be representative of federal lands and areas of mixed federal and private lands throughout the range
5464 of the Northern Spotted Owl because the study areas were large, distributed across a broad geographic
5465 region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

5466 Occupancy data is based on the presence or absence of owls from known sites. In order for estimates of
5467 occupancy to be valid, survey efforts must be consistent over time and the detection probability (the
5468 probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead
5469 to high variation in detection probability which can skew estimates of occupancy if not accounted for.
5470 Although an evaluation of occupancy rates has not been included in previous demographic meta-
5471 analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the
5472 number of territorial owls detected on all 11 areas was lower at the end of the study period than at the
5473 beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling
5474 for the first time. Preliminary results show that occupancy rates have declined at all three California
5475 study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on
5476 occupancy by increasing the local territory extinction rate.

5477 Occupancy has been shown to be in decline for areas outside the California demographic study areas as
5478 well. For example, the southern Cascades and interior Klamath provinces of California determined
5479 occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl
5480 declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

5481 It is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of
5482 demographic rates across the range indicate the declines in demographic parameters, including
5483 population size, have accelerated. The level of decline does not seem to be slowing even with the
5484 implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at
5485 threats leading to these declines is warranted, including reevaluation of the effectiveness or management
5486 techniques across the Northern Spotted Owl range in California.

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5487 **Predation**

5488 Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-
5489 tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The
5490 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted
5491 Owls is not a threat to the population. In the case of documented Barred Owl aggression toward
5492 Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented
5493 mortalities were due to territorial aggression. Given that predation is not considered to be a major
5494 threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly
5495 manage predation issues.

5496 **Competition**

5497 Over the last several decades, Barred Owls have gradually moved further into the range of the Northern
5498 Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been
5499 present the longest (British Columbia and Washington), with fewer detections made in the southern
5500 edge of the range (California) where they have been present for a shorter duration. Currently, Barred
5501 Owls have been documented in all portions of the Northern Spotted Owl range throughout California,
5502 though densities of Barred Owls are unknown.

5503 Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to
5504 the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most
5505 important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat
5506 and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong
5507 indication that the two species can coexist over time, sharing the same habitat and prey-base, because
5508 there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and
5509 not by Barred Owls.

5510 Public workshops held by the USFWS have resulted in four published and one unpublished meta-
5511 analyses since 1994 to assess population parameters, such as abundance, trend, and survival. These
5512 analyses show that in areas where Barred Owls are present, the decline in Northern Spotted Owl
5513 abundance has been steeper than where the Barred Owl was absent. Declines have been more
5514 prevalent where Barred Owls density was greatest. Northern Spotted Owl adult survival has declined in
5515 a majority of the range where Barred Owls were present, with a more gradual decline noted in California
5516 largely attributed to the relatively more recent Barred Owl expansion into this portion of the range.
5517 Presence of Barred Owls in or near Northern Spotted Owl territories is also thought to negatively impact
5518 fecundity, survival, and occupancy of Northern Spotted Owls.

5519 Experimental studies to remove Barred Owls conducted in California demonstrated that Northern
5520 Spotted Owl occupancy decreases with Barred Owl presence and increases with Barred Owl removal,
5521 suggesting that Barred Owls are displacing Northern Spotted Owls from their territories, forcing them
5522 into lower quality breeding and foraging habitat.

Comment [ABF113]: See my previous comment about the number and how many published

Comment [ABF114]: I would phrase this as "where barred owl detections are more frequent and widespread"

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5523 Given the severity of impacts and the quick range expansion into California, Barred Owl is considered
5524 one of the major threats to Northern Spotted Owl populations in California. More research is needed to
5525 assess Northern Spotted Owl site occupancy, reproduction, and survival in the face of Barred Owl
5526 presence, including the implementation of experimental removal of Barred Owls. Resource partitioning
5527 between the two species also needs further investigations.

5528 **Disease**

5529 Several studies indicate that raptors, including Spotted Owls, may be impacted at some level by disease
5530 and insect infestations (e.g., West Nile Virus, avian influenza, avian malaria, Leucocytozoonosis, fly/mite
5531 infestations). The 2011 Northern Spotted Owl Revised Recovery Plan recognizes that disease threat is
5532 unknown, but may significantly impact owls. Disease occurrence in Northern Spotted Owls is likely
5533 under-reported because owls tend to inhabit remote areas and, therefore, there is a small likelihood of
5534 carcass recovery for testing. Disease may be a significant threat to Northern Spotted Owls, but more
5535 research is needed to better understand prevalence and magnitude of impacts in owl populations in
5536 California.

5537 **Other Natural Events or Human-related Activities**

5538 *Precipitation and Temperature Changes*

5539 Most climate projection scenarios agree that the forests in the Northern Spotted Owl's range will have
5540 wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased
5541 frequency and intensity of disturbance events. According to many climate projections, the frequency
5542 and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will
5543 increase over time. Vulnerability to disturbance, such as wildfire, disease, and insect outbreaks, is
5544 expected to increase in most forests in the Northwest and may change forest composition and structure
5545 depending on changes to climate. Climate modeling studies agree that forest wildfire occurrence and
5546 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced
5547 snowpack, earlier spring snowmelts, and longer drier summers.

5548 Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These
5549 studies indicate that winter precipitation is closely associated with a decrease in survival and
5550 recruitment; population growth was positively associated with wetter conditions during the growing
5551 season (May through October) and negatively associated with cold/wet winters and nesting seasons,
5552 and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction
5553 increased with late nesting season precipitation and decreased with warm temperatures; and owls may
5554 be more sensitive to changes in spring time climatic events.

5555 It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many
5556 climate projections forecasting steady changes in the future. Climate change studies predict future
5557 conditions that may negatively impact owls, such as wet and cold springs, more frequent and sever

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summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased frequency of severe wildfire events. Yet in some instances projected future conditions, such as increased frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other areas of the range. Looking at past precipitation and temperature trends, drying trends across most of the range coupled with warmer winters and cooler summers in the interior and cooler winters and warmer summers along the coast may play a role in both owl and prey population dynamics. More research is needed to assess the extent of these climate impacts on survival, population growth, and reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of climate change outweigh the positive ones.

Climate change will likely impact the Northern Spotted Owl in California, but the degree to which it is a threat to the species continued existence in the short- or long-term needs further investigation. During long-term landscape planning related to Northern Spotted Owls and their habitat, potential climate change impacts should be analyzed and incorporated.

Recreational Activity

Relatively few studies have been conducted on the impact of recreational activity on Northern Spotted Owls. A few studies suggest that stress levels increase in individual Northern Spotted Owls when exposed to motorcycle activities, timber harvest activities, and presence of hikers. It is clear recreational activities impact Northern Spotted Owls to some extent, but the level to which these activities may impact owls has yet to be determined. It is unlikely anthropogenic stress events associated with recreation will impact Northern Spotted Owl reproduction and survival to any great extent, though further research is warranted.

Loss of Genetic Variation

Loss of genetic variation is not considered to be a major threat to Northern Spotted Owls at this time. Some recent studies provide evidence that a population bottleneck may have occurred within the last few decades across the range of the Northern Spotted Owl; though no effect was documented for Northwest California.

Management Recommendations

The goal of the Department is to secure recovery and long-term survival of the Northern Spotted Owl across their historic range. The Department has evaluated existing management measures and has identified the following management recommendations, listed in no particular order, as necessary to help achieve the aforementioned goal. Many of these recommendations are adapted from the USFWS Northern Spotted Owl Recovery Plan (USFWS 2011a) and are based on the best available scientific

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5593 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where
5594 applicable. As new information becomes available, recommendations may be further refined.

5595 Planning and Timber Practices

- 5596 1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is
5597 consistent with the recovery of the species (see RA14).
- 5598 2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-
5599 range planning, setting priorities for scientific research and investigations, and/or when making
5600 major decisions affecting the Northern Spotted Owl (see RA5).
- 5601 3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative
5602 opportunities for nonfederal landowners to engage in management strategies (see RA15).
- 5603 4. Consider long-term maintenance of local forest management infrastructure as a priority in
5604 planning and land management decisions (see RA16).
- 5605 5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and
5606 contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of
5607 Northern Spotted Owls (see RA21).
- 5608 6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential
5609 recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in
5610 California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration,
5611 HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
- 5612 7. Improve thorough documentation of harvest prescription methods within timber harvest plans
5613 and a rigorous evaluation of post-harvest levels of foraging, nesting, and roosting habitat.
- 5614 8. Evaluate the effects of silvicultural practices on important prey species (e.g., flying squirrel,
5615 woodrat) and their habitat.

5616 Population Trend and Demographic Parameters

- 5617 9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if
5618 the California population is decreasing, stationary or increasing (see RA2).
- 5619 10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy
5620 across its California range (see RA3).
- 5621 11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival,
5622 population growth and reproductive rates of Northern Spotted Owls in California, and
5623 determine if negative impacts of climate change outweigh the positive ones.

5624 Habitat

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- 5625 12. Manage Northern Spotted Owl habitat in a way that accelerates the development of structural
5626 complexity and biological diversity that benefits Spotted Owl (see RA6)
- 5627 13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl
5628 habitat) while allowing for other threats, such as wildfire and insects, to be addressed by
5629 restoration management actions (see RA32).
- 5630 14. Conserve Northern Spotted Owl sites and high value habitat to provide additional demographic
5631 support to population dynamics (see RA10).
- 5632 15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to
5633 inform decisions concerning the possible development of habitat conservation networks in
5634 California (see RA4).
- 5635 16. Assess habitat requirements for, and barriers to, dispersal in California through research on
5636 Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and
5637 availability, and habitat modeling.
- 5638 17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath
5639 Province) to assist evaluating landscape-level issues in the Provinces in California, including
5640 monitoring and adaptive management actions (see RA7 and RA9).
- 5641 Wildfire
- 5642 18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).
- 5643 19. Retain large, dense patches of forests embedded in a matrix with reduced stand densities to
5644 limit the potential for stand-replacement fire and competitive pressure on old trees.
- 5645 20. Conduct experiments to better understand how vegetation management treatments (e.g.,
5646 thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern
5647 Spotted Owl habitat, prey abundance and distribution, and demographic performance (see
5648 RA11).
- 5649 a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in
5650 use of burned areas for foraging warrants additional research on long-term use of
5651 burned areas post-fire.
- 5652 21. Gather information on the effect of historical fire suppression and current fire regimes on owl
5653 habitat, especially on the quality of habitat as assessed through demographic rates at individual
5654 owl territories.
- 5655 22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of
5656 Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.

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- 5657 23. Develop a process for evaluating the likely effects of post-fire management activities, such as
5658 salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate
5659 this process into post-fire management decisions.
- 5660 24. Concentrate post-fire silvicultural activities on conserving and restoring habitat elements that
5661 take a long time to develop, such as large trees, medium and large snags, downed wood (see
5662 RA12).
- 5663 Barred Owl
- 5664 25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy,
5665 reproduction, and survival in California (see RA23).
- 5666 26. Promote experimental removal of Barred Owls within Northern Spotted Owl range, and if lethal
5667 removal is deemed a long-term management tool to manage negative effects of Barred Owls,
5668 explore methods for implementation within California (see RA22, RA29, and RA30).
- 5669 27. Investigate the potential for resource partitioning of Barred Owls and Northern Spotted Owls
5670 (see RA26).
- 5671 28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted
5672 Owl interactions.
- 5673 a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by
5674 the presence or absence of Barred Owls, but other unknown factors may also play a
5675 role.
- 5676 Disease and Contaminants
- 5677 29. Monitor prevalence and extent of sudden oak death within the Northern Spotted Owl range in
5678 California, and address as appropriate (see RA17).
- 5679 30. Investigate the potential influences of sudden oak death on Northern Spotted Owl habitat,
5680 occupancy, and prey species abundance over the short- and long-term.
- 5681 31. Expand assessment of the impacts of marijuana cultivation (both illegal and legal) on the
5682 Northern Spotted Owl and their habitat.
- 5683 a. The watersheds analyzed to date comprise only 4% of the Northern Spotted Owl range.
5684 Uncertainties in the dataset analyzed make it likely that the density of legal cultivation
5685 sites is higher than reported in the analysis. In addition, given the measured density of
5686 cultivation sites within Humboldt, Trinity and Mendocino counties potential impact of
5687 marijuana cultivation sites on spotted owl habitat should be evaluated further.
- 5688 b. Impacts of illegal cultivation to Northern Spotted Owls (e.g., habitat loss, exposure to
5689 toxins such and rodenticides) are largely unknown. Recent studies on anticoagulant

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5690 exposure in fisher suggests some unknown impact to the owl since prey-base is shared
5691 between the two species.

5692 32. Monitor prevalence of avian diseases (e.g., West Nile Virus, avian flu, *Plasmodium* spp.) in the
5693 Northern Spotted Owl population, and address as appropriate (see RA17).

5694 33. Investigate the extent of stress induced impacts on Northern Spotted Owl reproduction and
5695 survival due to recreational activities (e.g., hiking, off-road vehicular use).

5696 Listing Recommendation

5697 [TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]
5698

5699 Protection Afforded by Listing

5700
5701 The following is a discussion of potential protection that could be afforded to the Northern Spotted Owl
5702 in California if listed under CESA. While the protections identified in this section would help to ensure
5703 the future conservation of Northern Spotted Owls, there are protections now in place that would
5704 continue if the owl were not listed under CESA. These include current protections afforded under the
5705 Northern Spotted Owl federal status, protections afforded under the Forest Practice Rules, coverage of
5706 the owl under HCPs and NCCPs, current CEQA requirements, and existing laws and regulations that
5707 make it illegal under State law to take owls in California.

5708 It is the policy of the Department to conserve, protect, restore and enhance any endangered or any
5709 threatened species and its habitat (Fish & G. Code, § 2052.). The conservation, protection, and
5710 enhancement of listed species and their habitat is of statewide concern (Fish & G. Code, § 2051(c)).
5711 CESA defines “take” as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture,
5712 or kill. (Id. , § 86). Any person violating the take prohibition would be punishable under State law. When
5713 take is authorized through an incidental take permit, the impacts of the take must be minimized and
5714 fully mitigated, among other requirements.

5715 Increased protection of Northern Spotted Owl following listing would occur with required public agency
5716 environmental review under CEQA. CEQA requires affected public agencies to analyze and disclose
5717 project-related environmental effects, including potentially significant impacts on endangered, rare, and
5718 threatened species. Where significant impacts are identified under CEQA, the Department expects
5719 project-specific required avoidance, minimization, and mitigation measures will also benefit the species.

5720 CEQA would require analysis of potential impacts to Northern Spotted Owl regardless of listing status
5721 under CESA. In common practice, potential impacts to listed species is examined more closely in CEQA
5722 documents than potential impacts to unlisted species. State listing, in this respect, and required
5723 consultation with the Department during state and local agency environmental review under CEQA, is

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5724 also expected to benefit the species in terms of related impacts for individual projects that might
5725 otherwise occur absent listing.

5726 Without listing, Northern Spotted Owl take for research purposes is allowed via a Scientific Collecting
5727 Permit, and federal ESA 10a(1)(a). With listing, a state research Memoranda of Understanding (MOU)
5728 would also be required (Fish & G. Code, § 2081, subd. (a)). The added oversight allowed from MOU
5729 process is expected to benefit the species in terms of added coordination and research design, but will
5730 not likely add any additional protection.

5731 In listing the Northern Spotted Owl under CESA, the Department would expect an increased level of
5732 coordination among public agencies, such as USFS, CAL FIRE, and the USFWS, and with private timber
5733 companies, increased level of Department involvement in the THP review and approval process, more
5734 regular and thorough acquisition of data, and a reevaluation of current management practices for the
5735 species. In addition, if the Northern Spotted Owl is listed under CESA, the likelihood that land and
5736 resource management agencies will allocate funds towards protection and recovery actions may
5737 increase.

Economic Considerations

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5739
5740 The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).
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Appendix 1. Forest Practice Rule definitions of silvicultural prescriptions.

The Forest Practice Rules differentiate silvicultural methods into four silvicultural categories. These silvicultural categories include even-aged management, uneven-aged management, intermediate treatments, and special prescriptions.

An Alternative silvicultural prescription can be included in a timber harvest plan when an alternative regeneration method or intermediate treatment is more effective or more feasible than any of the standard silvicultural methods.

Even-aged Management

Section 913.1 – Even-aged management are methods designed to replace a harvestable stand with well-spaced growing trees of commercial species.

Clearcutting

Section 913.1(b) – Clearcutting regeneration method involves the removal of a stand in one harvest.

Seed Tree

Section 913.1(c) – The seed tree regeneration method involves the removal of a stand in one harvest except for well distributed seed trees of desired species which are left singly or in groups to restock the harvested area.

Seed Tree Seed Step

Section 913.1(c)(1) – Seed Tree Seed Step: The seed tree seed step is the regeneration step and shall meet the following requirements:

- (A) Retention of at least the following basal area of seed trees per acre which are 18 inches dbh or greater:
 - 1. Fifteen square feet basal area on site I, II and III lands and
 - 2. Twelve square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

- (B) No point within the logged area shall be more than 150 feet from a seed tree.
- (C) Seed tree species and site preparation measures shall be specified in the plan by the RPF.
- (D) Seed trees shall be marked by or under the supervision of an RPF prior to felling operations.
- (E) If natural regeneration is inadequate within two years after the first August following completion of timber operations, seed trees may be harvested and artificial regeneration shall be used to meet the requirements of Section 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)].

Seed Tree Removal Step

Section 913.1(c)(2) – No more than 15 predominant trees per acre may be removed in the seed tree removal step. Not more than 50 sq. ft. of basal area of predominant trees per acre may be removed in the seed tree removal step. The seed tree removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 912.7(b)(1)[932.7(b)(1), 952.7(b)(1)].

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Shelterwood

Section 913.1(d) – The shelterwood regeneration method reproduces a stand via a series of harvests (preparatory, seed, and removal). The preparatory step is utilized to improve the crown development, seed production capacity and wind firmness of designated seed trees. The seed step is utilized to promote natural reproduction from seed. The removal step is utilized when a fully stocked stand of reproduction has become established, and this step includes the removal of the protective overstory trees. The shelterwood regeneration method is normally utilized when some shade canopy is considered desirable for the establishment of regeneration.

Shelterwood Preparatory Step

Section 913.1(d)(1) – The shelterwood preparatory step shall meet the following minimum standards:

(A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.

1. Thirty square feet basal area on site I, II and III lands and

2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 100 ft. from a seed tree.

(C) Seed tree species shall be specified in the plan by the RPF.

(D) At least 125 sq. ft. of basal area per acre on Site I lands, and 75 sq. ft. of basal area per acre on Site II and III lands and 50 sq. ft. of basal area per acre on site IV and V lands shall be retained.

(E) The minimum stocking standards of 14 CCR § 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)] shall be met immediately upon completion of operations.

Shelterwood Seed Step

Section 913.1(d)(2) – The shelterwood seed step is the regeneration step and shall meet the following standards:

(A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.

1. Thirty square feet basal area on site I, II and III lands and

2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 100 ft. from a seed tree.

(C) Seed tree species and site preparation measures shall be specified in the plan by the RPF.

(D) Seed trees shall be marked by or under the supervision of an RPF prior to felling operations.

(E) If natural regeneration is inadequate within two years after the first August following completion of timber operations, seed trees may be harvested and artificial regeneration shall be used to meet the requirements of 14 CCR § 912.7(b)(1), [932.7(b)(1), 952.7(b)(1)].

(F) In the absence of a Sustained Yield Plan, to maintain and improve tree species diversity, genetic material and seed production, trees of each native commercial species where present at the time of harvest shall be retained after harvest.

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These leave trees shall be representative of the best phenotypes available in the preharvest stand. The RPF may propose and the Director may agree to a species specific plan in the THP which protects existing regeneration or provides for regeneration in-lieu of retaining trees.

Shelterwood Removal Step [Coast only]

Section 933.1(d)(3) - The shelterwood removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 912.7(b)(1). Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used once in the life of the stand. Regeneration shall not be harvested during the shelterwood removal step unless the trees are dead, dying or diseased or substantially damaged by timber operations. The minimum stocking standards of Section 912.7(b)(1) shall be met immediately upon completion of operations. The size limitations, and separation (spacing) by logical logging unit requirements, of Section 913.1(a) are applicable unless the post-harvest stand, regardless of average diameter, meets the stocking standards of Section 913.3(a)(1)(A) or (B)]. Not more than 32 predominant trees per acre may be removed in the shelterwood removal step. Not more than 100 square feet of basal area of predominant trees per acre may be removed in the shelterwood removal step.

Shelterwood Removal Step [Northern and Southern]

The shelterwood removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 932.7(b)(1) [952.7(b)(1)]. Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used once in the life of the stand. Regeneration shall not be harvested during the shelterwood removal step unless the trees are dead, dying or diseased or substantially damaged by timber operations. The minimum stocking standards of Section 932.7(b)(1) [952.7(b)(1)] shall be met immediately upon completion of operations. If the extent and intensity of the ground disturbance caused by the harvest is essentially the same as would have been caused by a clearcut or will cause adverse cumulative effects on wildlife as determined by the RPF or Director, the size limitations, and separation (spacing) by logical logging unit requirements of Section 933.1(a) [953.1(a)] are applicable unless the post-harvest stand, regardless of average diameter, meets area stocking standards of Section 933.3(a)(1)(A) or (B) [953.3(a)(1)(A) or (B)].

Uneven-aged Management

Sections 895.1 and 4593.2(c) – Uneven-aged management means the management of a specific forest, with the goal of establishing a well-stocked stand of various age classes and which permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop. Also defined in the SAF Dictionary of Forestry as “a stand of trees of three or more distinct age classes, either intimately mixed or in small groups”.

Selection/Group Selection

Section 913.2(a) – Under the selection regeneration method, the trees are removed individually or in small groups sized from 0.25 to 2.5 acres.

Transition

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Section 913.2(b) – The transition method may be used to develop an unevenaged stand from a stand that currently has an unbalanced irregular or evenaged structure. The transition method involves the removal of trees individually or in small groups from irregular or evenaged stands to create a balanced stand structure and to obtain natural reproduction.

Intermediate Treatments

Section 895.1 – Intermediate treatments means harvests conducted to modify or guide the development of an existing stand of trees, but not to replace (regenerate) the stand with a new one. The treatments involve the removal of trees to allow expansion of the crowns and root systems.

Commercial Thinning

Section 913.3(a) – Commercial thinning is the removal of trees in a young-growth stand maintain or increase average stand diameter of the residual crop trees, promote timber growth and/or improve forest health.

Sanitation-Salvage

Section 913.3(b) – Sanitation is the removal of insect attacked or diseased trees in order to maintain or improve the health of the stand. Salvage is the removal of only those trees which are dead, dying, or deteriorating, because of damage from fire, wind, insects, disease, flood or other injurious agent.

Special Prescriptions

Section 913.4 – Special Prescriptions are special harvesting methods which are appropriate under certain conditions.

Special Treatment Area

Sections 895.1 – Special Treatment Areas are specific locations which contain one or more of the following significant resource features which may be at risk during timber operations:

- a. Within 200 feet of the watercourse transition line of federal or state designated wild and scenic rivers;
- b. Within 200 feet of national, state, regional, county or municipal park boundaries;
- c. Key habitat areas of federal or state designated threatened, rare or endangered species;
- d. Coastal Commission special treatment areas;
- e. Within 200 feet of state designated scenic highways or within scenic corridors established pursuant to Article 2.5 (commencing with Section 260) of Chapter 2 of Division 1 and Section 154 of Chap. 1 of Div. 1 of the Streets and Highways Code.

Section 913.4(a) – Special consideration in Special Treatment Areas shall be given to selection of a regeneration method or intermediate treatment compatible with the objectives for which the special area was established. Such areas shall be identified in the plan. To assure the integrity of legally designated historical and archaeological sites and legally designated ecological reserves, and that the objectives of the special treatment areas are met, the RPF and the Director may agree, after on-the-ground inspection, if requested by either party, on specific silvicultural and logging practices to protect such areas. The Director shall notify affected agencies or groups with expertise in the resource involved in the special treatment area of any such areas located during the THP review process.

Rehabilitation

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6721 Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial
6722 timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7)
6723 prior to any timber operations on such lands, an area may be harvested provided it is restocked
6724 in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be
6725 included in the THP. The regeneration plan shall include site preparation, method of
6726 regeneration, and other information appropriate to evaluate the plan.
6727
6728 Fuelbreak/Defensible Space
6729 Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a
6730 shaded fuel break or defensible space in an area to reduce the potential for wildfires and the
6731 damage they might cause.
6732
6733 Variable Retention
6734 Section 913.4(d) - Variable retention is an approach to harvesting based on the retention of
6735 structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for
6736 integration into the post-harvest stand to achieve various ecological, social and geomorphic
6737 objectives.
6738
6739 Conversion
6740 Section 1100 – within non-timberland production zone (TPZ) timberland, transforming
6741 timberland to a nontimber growing use through timber operations.
6742
6743 **Alternative Prescription**
6744 A written analysis of preharvest and postharvest timber stand conditions and a description of the
6745 silvicultural practices and systems to be used in lieu of the standard methods. An Alternative silvicultural
6746 prescription can be included in a timber harvest plan when an alternative regeneration method or
6747 intermediate treatment is more effective or more feasible than any of the standard silvicultural
6748 methods.
6749 Section 913.6 – When an Alternative method is used, the plan must include a statement of which
6750 silvicultural method in the current District rules is most nearly appropriate or feasible and an
6751 explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how
6752 the proposed alternative prescription will differ from the most nearly feasible method in terms of
6753 securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in
6754 terms of fire, insect and disease protection.
6755
6756
6757 NonTimberland Area
6758 Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land,
6759 other than land owned by the federal government and land designated by the board as experimental
6760 forest land, which is available for, and capable of, growing a crop of trees of a commercial species used
6761 to produce lumber and other forest products, including Christmas trees.
6762
6763 Road Right of Way
6764 No strict definition
6765
6766

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6767 **Appendix 2: Forest Practice Rule definitions regarding Northern Spotted Owl or**
6768 **their habitat**

6769 **Activity Center (AC)** means a known northern Spotted Owl site documented from detections, pursuant
6770 to the USFWS document "Protocol For Surveying Proposed Management Activities That May Impact
6771 Northern Spotted Owls" revised March 17, 1992.

6772 (a) An AC is established by:

6773 (1) Resident Single Status is established by:

6774 (A) The presence or response of a single owl within the same general area on three or
6775 more occasions within a breeding season, with no response by an owl of the opposite
6776 sex after a complete survey;

6777 (B) Multiple responses over several years (i.e., two responses in year one and one
6778 response in year 2, from the same general area).

6779 (2) Pair Status Unknown is where the presence or response of two birds of the opposite sex is
6780 detected but pair status cannot be determined and where at least one member must meet the
6781 resident single requirements.

6782 (3) Pair Status wherein a male and female are heard and/or observed (either initially or through
6783 their movement) in proximity (less than one-quarter mile apart) to each other on the same visit;
6784 or a male takes a mouse to a female; or a female is detected on the nest; or one or both adults
6785 are observed with young.

6786 (4) Unoccupied Status where no responses have been obtained from a previously identified
6787 northern Spotted Owl activity center after 3 years of survey, barring other evidence to the
6788 contrary.

6789 An AC with unoccupied status will not be considered an AC when it has been evaluated and a
6790 determination made by the Director. The determination shall be based upon available information on
6791 survey history, habitat conditions within the home range, and changes to habitat that may have
6792 occurred since the northern Spotted Owl site was first identified.

6793 **Functional Foraging Habitat** is dependent upon the presence and availability of prey on the forest floor
6794 or in the canopy; presence of accessible perching limbs; and adjacency to stands with canopy closures
6795 >40%. Average stem diameter is usually >6" dbh for hardwoods and >11" dbh for conifers among
6796 dominants, and co-dominants, and the total overhead canopy closure, including intermediate trees is at
6797 least 40%. Where overall canopy closure is >80%, foraging habitat is limited to areas with ample flight
6798 space below limbs and among stems. Foraging habitat in smaller size classes and lower percentage
6799 canopy closures must be justified by local information.

6800 **Functional Nesting Habitat** means habitat with a dominant and co-dominant tree canopy closure of at
6801 least 40% and a total canopy (including dominant, co-dominant, and intermediates) of at least 60%.
6802 Usually the stand is distinctly multi-layered with an average stem diameter in dominant, and co-
6803 dominant conifers, and hardwoods >11" dbh. The stand usually consists of several tree species
6804 (including hardwoods) of mixed sizes. All nests, snags, down logs, and decadent trees shall also be
6805 considered as part of the habitat. Nesting substrates are provided by broken tops, cavities, or platforms

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6806 such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are
6807 known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with
6808 characteristics of topographic relief and aspect which alter microclimates.

6809 **Functional Roosting Habitat** during the territorial breeding season, consists of stands where
6810 average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers
6811 provide an average of at least 40% canopy closure but the stand can have a high degree of variability.
6812 Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for
6813 protection from various environmental conditions, including wind, heat, and precipitation.

6814 **Owl Habitat** means Type A, B, or C owl habitat or those areas with functional foraging habitat,
6815 functional nesting habitat, and functional roosting habitat which support the owl's biological needs for
6816 breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the
6817 functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls
6818 are known to occasionally inhabit less than optimal forest structure, local information can be used to
6819 justify the modification of functional habitat definitions.

6820 **Type A Owl Habitat** means timber stands that have as a minimum the following characteristics for
6821 live-tree structure:

- 6822 **1. Canopy layers:** The stand has two distinct tiers or is multi-layered with dominant
6823 conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for
6824 some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.
6825 **2. Canopy Closure:** The canopy closure of conifers greater than 120 ft. tall (or greater than
6826 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
6827 and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.
6828 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than nine
6829 stems per acre and not less than six stems per acre and includes a component of trees with sparse,
6830 broken, or dead tops.
6831 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6832 than 15 stems per acre and not less than 8 stems per acre.
6833 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
6834 than 50 stems per acre and not less than 20 stems per acre.
6835

6836 **Type B Owl Habitat** means timber stands that have as a minimum the following characteristics for
6837 live-tree structure:

- 6838 **1. Canopy Layers:** Moderately to strongly two-tiered or multi-layered with dominant
6839 conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some
6840 montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.
6841 **2. Canopy Closure:** The canopy closure of conifers greater than 100 ft. tall (or greater than
6842 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
6843 and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.
6844 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than six

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6845 stems per acre and not less than two stems per acre.

6846 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6847 than 25 stems per acre and not less than 20 stems per acre.

6848 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
6849 than 50 stems per acre and not less than 20 stems per acre.

6850 **Type C Owl Habitat** means timber stands that have as a minimum the following characteristics for
6851 live-tree structure:

6852 **1. Canopy Layers:** Uniform to moderately layered with dominant conifers or hardwoods 50
6853 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.

6854 **2. Canopy Closure:** The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages
6855 greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is
6856 greater than 60%.

6857 **3. Large Trees:** The density of conifers greater than 35 inches dbh averages less than six
6858 stems per acre and may be absent.

6859 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6860 than 15 stems per acre, but may be absent.

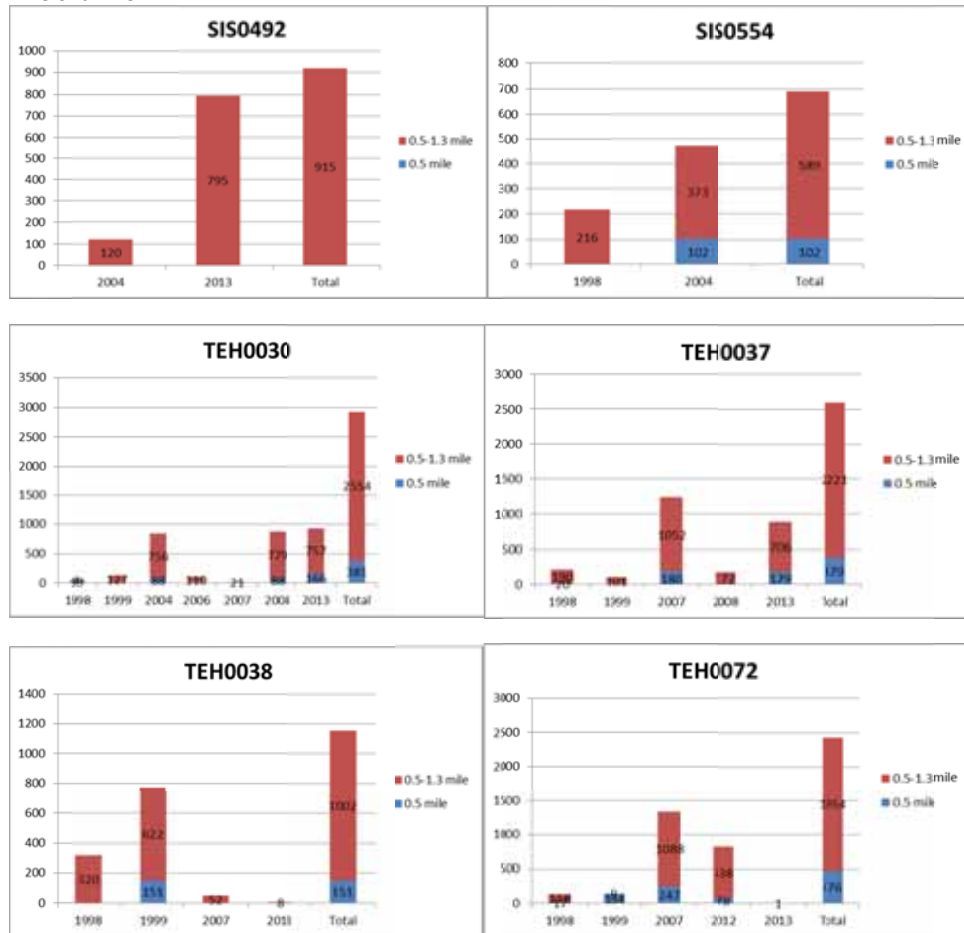
6861 **5. Small Trees:** The density of conifers or hardwoods less than 18 inches dbh averages
6862 more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the
6863 stand, including small, medium, and large trees is greater than 10 inches.

6864

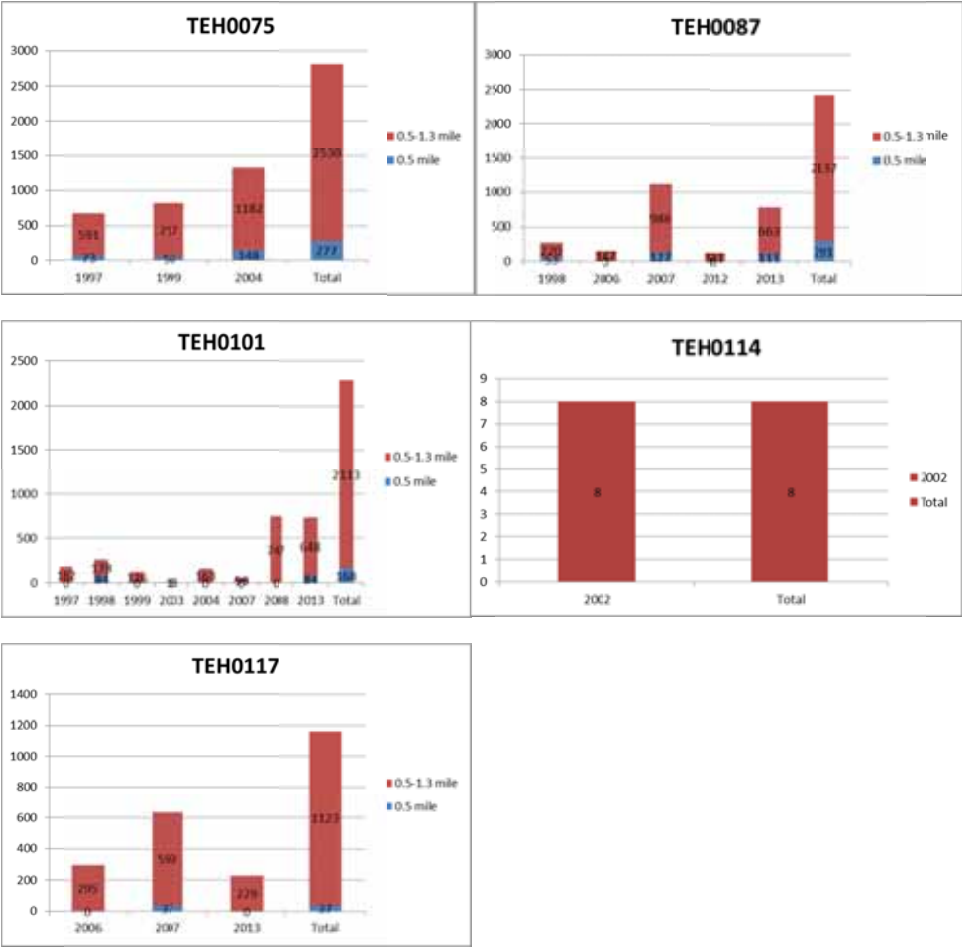
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Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

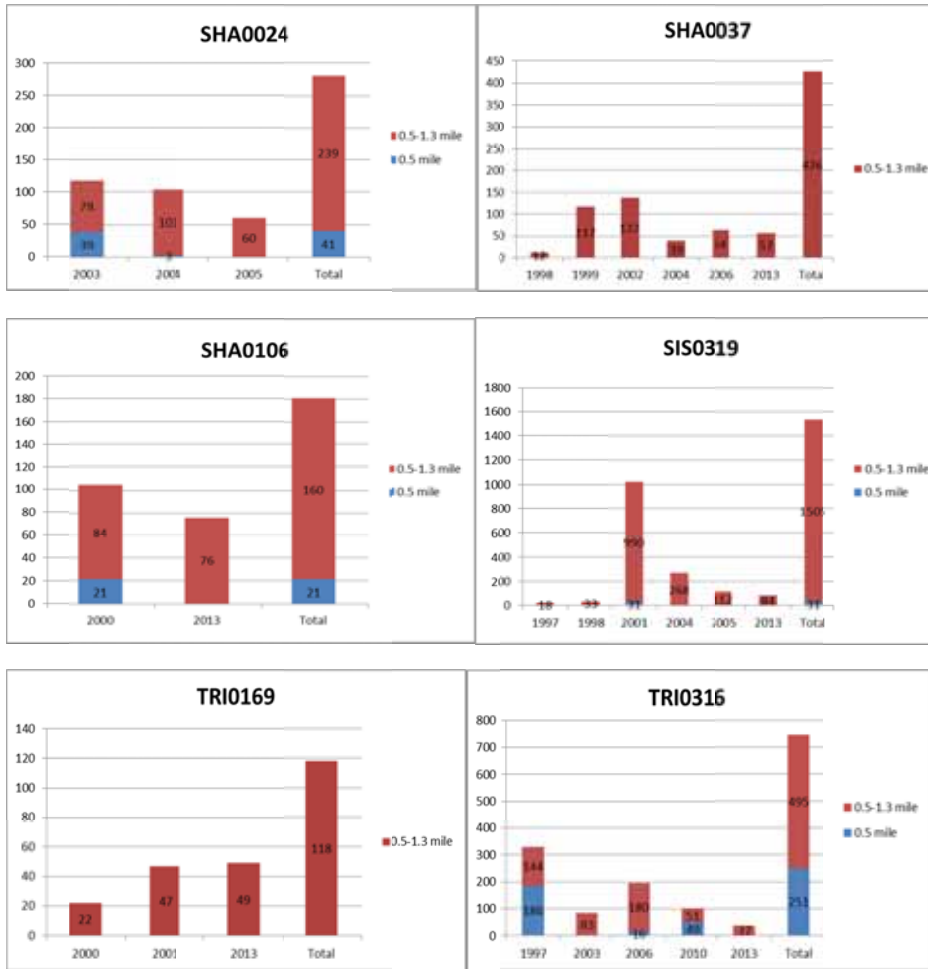


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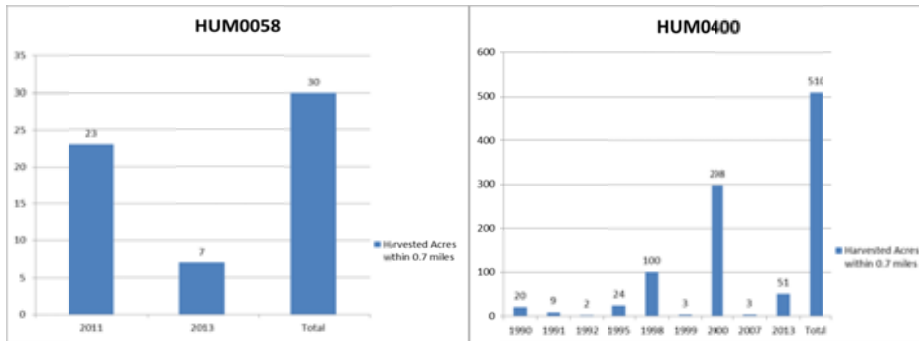
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6870 THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3
6871 mile of an AC

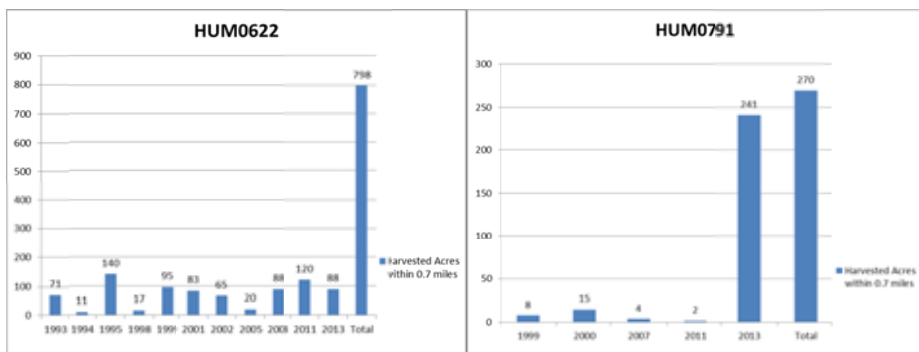


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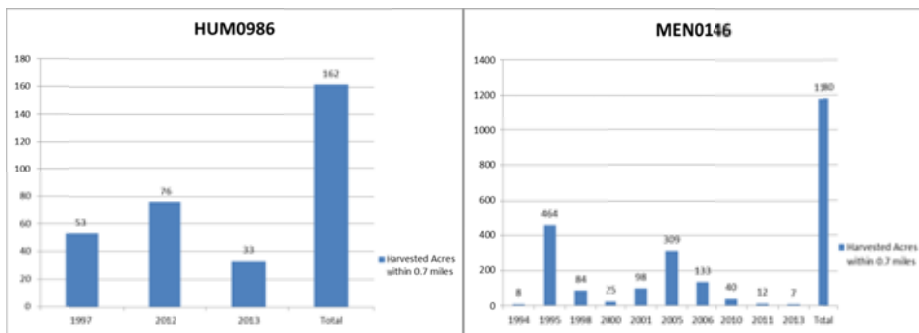
6885 THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



6887

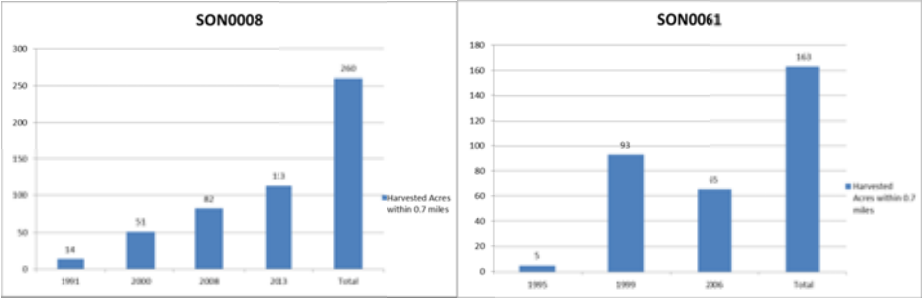
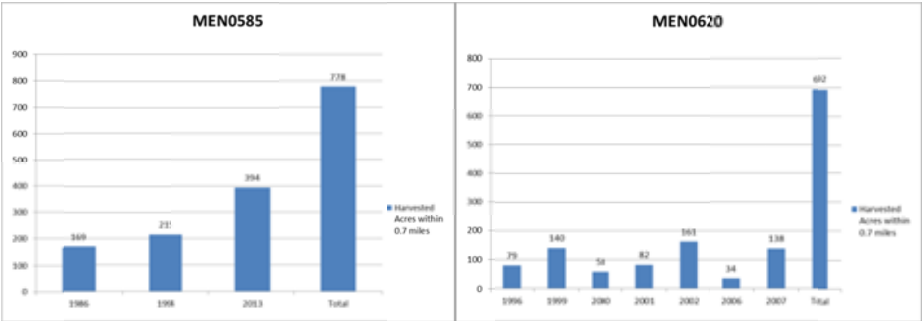
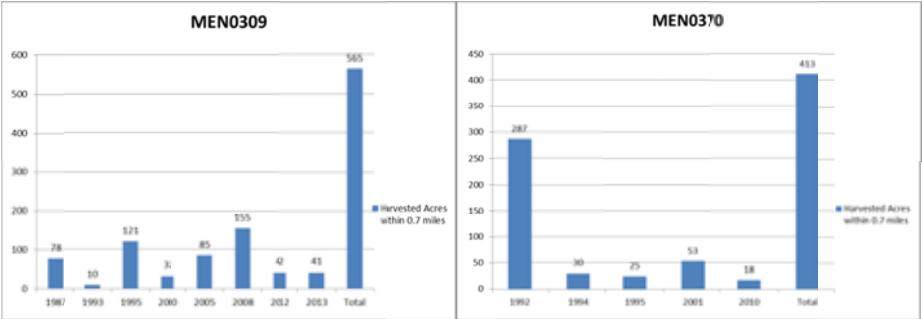


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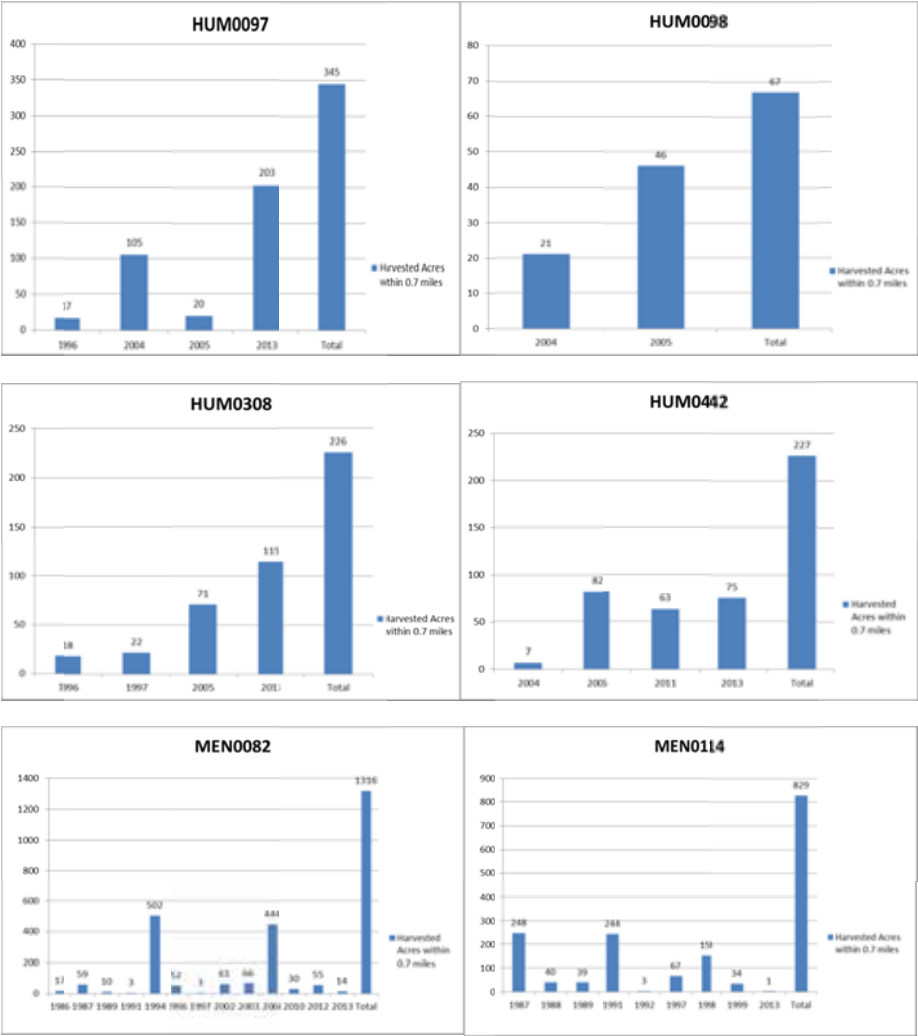
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6895 THP’s utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



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6900	Appendix 4. List of Acronyms and Abbreviations	
6901		
6902	AC	Activity Center
6903	AMA	Adaptive Management Areas
6904	AR	Anticoagulant Rodenticides
6905	BLM	Bureau of Land Management
6906	Board	Board of Forestry and Fire Protection
6907	BO	Biological Opinion
6908	BOE	Board of Equalization
6909	BOF	State Board of Forestry and Fire Protection
6910	CA State Parks	California Department of Parks and Recreation
6911	CAL FIRE	California Department of Forestry and Fire Protection
6912	Caltrans	California Department of Transportation
6913	CBD	Center for Biological Diversity
6914	CD	Consistency Determination
6915	CEQA	California Environmental Quality Act
6916	CESA	California Endangered Species Act
6917	CCAA	Candidate Conservation Agreement with Assurances
6918	CDFW	California Department of Fish and Wildlife
6919	CI	Confidence Interval
6920	CNDDDB	California Natural Diversity Database
6921	Commission	Fish and Game Commission
6922	CPV	Canine Parvovirus
6923	CSA	Conservation Support Areas
6924	CWHR	California Wildlife Habitat Relationships
6925	DBH	Diameter at Breast Height
6926	DSA	Density Study Area
6927	Department	California Department of Fish and Wildlife
6928	EIR	Environmental Impact Report
6929	EPA	Environmental Protection Agency
6930	ESA	Federal Endangered Species Act
6931	FEIS	Final Environmental Impact Statement
6932	FRGP	Fisheries Restoration Grant Program
6933	FGS	Fruit Growers Supply Company
6934	FEMAT	Forest Ecosystem Management Assessment Team
6935	FIA	Forest Inventory Analysis
6936	FMP	Forest Management Plan
6937	FPA	Forest Practice Act
6938	FRI	Fire Return Interval
6939	FSC	Forest Stewardship Council
6940	GDR	Green Diamond Resource Company study area
6941	GDRC	Green Diamond Resource Company
6942	ITP	Incidental Take Permit
6943	ITS	Incidental Take Statement
6944	JDSF	Jackson Demonstration State Forest
6945	HCP	Habitat Conservation Plan
6946	HFP	Habitat Fitness Potential

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6947	HCVF	High Conservation Value Forests
6948	HUP	Hoopa Indian Reservation study area
6949	HRC	Humboldt Redwood Company
6950	LSA	Late-Successional Areas
6951	LSAA	Lake or Streambed Alteration Agreement
6952	LSR	Late-Successional Reserve
6953	MBF	1,000 board-foot
6954	MIS	Management Indicator Species
6955	MMCA	Marbled Murrelet Conservation Areas
6956	MRC	Mendocino Redwood Company
6957	NCA	National Conservation Area
6958	NCCP	Natural Community Conservation Plan
6959	NIPF	Non-industrial private forest
6960	NPS	National Park Service
6961	NSO	Northern Spotted Owl
6962	NTMP	Nonindustrial Timber Management Plans
6963	NTO	Notice of Operations
6964	NWC	Northwest California study area
6965	NWFP	Northwest Forest Plan
6966	ORV	Off Road Vehicle
6967	PCB	Private Consulting Biologists
6968	PFT	Pacific Forest Trust
6969	PL	Pacific Lumber Company
6970	PRNS	Point Reyes National Seashore
6971	PSU	Primary Sampling Unit
6972	REF	Suppressed reproduction and growth
6973	RNSP	Redwood National and State Parks
6974	ROD	Record of Decision
6975	RPF	Registered Professional Foresters
6976	SEIS	Supplemental Environmental Impact Statement
6977	SHA	Safe Harbor Agreement
6978	SOMP	Spotted Owl Management Plans
6979	SOP	Spotted Owl Expert
6980	SORP	Spotted Owl Resource Plan
6981	SFI	Sustainable Forestry Initiative
6982	SP	State Park
6983	SPI	Sierra Pacific Industries
6984	TCP	Timberland Conservation Planning Program
6985	THP	Timber Harvest Plan
6986	TPZ	Timber Production Zone
6987	UCNRS	UC Natural Reserve System
6988	USFWS	U.S. Fish and Wildlife Service
6989	USFS	U.S. Forest Service
6990	USDA	United States Department of Agriculture
6991	USDI	United States Department of Interior
6992	USFS	United States Forest Service
6993	WCSA	Willow Creek Study Area
6994	WLPZ	Watercourse and Lake Protection Zones

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6995 WNV West Nile virus
6996

**EXTERNAL REVIEW OF
A STATUS REVIEW OF THE NORTHERN SPOTTED OWL (*Strix occidentalis caurina*) IN CALIFORNIA
Alan B. Franklin
25 November 2015**

As requested, I reviewed *A Status Review of the Northern Spotted Owl (Strix occidentalis caurina) in California*. I read the report in its entirety and focused mostly on conceptual issues and accuracy of the data and conclusions presented; I spent little time on editorial issues, such as editing grammar, etc. Overall, I thought the authors of the report provided an exhaustive, well-written and thoughtful review of the status of northern spotted owls in California. In general, I thought the document could have:

- Focused more on northern spotted owls in California, with less discussion on owls in other parts of their range (except to put spotted owls in California into a broader context)
- Included a number of additional references, especially some of the older literature, relevant to northern spotted owls to northern spotted owls in California; I included some of these in my comments.

Despite this and my other comments, I thought the authors did an excellent job. I included my comments and suggestions as minor comments that I incorporated into the draft document using Track Changes and more general comments that I included below for each major section of the report.

BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL SECTION

General Comments

1. I think the authors pointed out a number of factors that affected density estimates across the studies. However, I would argue more strongly that different methodology and time periods probably accounted for the differences than a number of the factors mentioned in the report. First, the denominator (area) matters in estimating density (see Figure 4 in Franklin et al. 1990). For example, some studies had large areas delineated, which were surveyed for owls (a more optimal approach used by, for example, the WCSA and GDRC studies) while others surveyed for owls and then delineated the survey area to determine density around owl detections (less optimal approach used by, for example, Sierra Pacific Industries. 2013. Northern spotted owls near Weaverville and Trinity Lake in Trinity County: Reporting results from within the landscape survey strategy area. Interim Report, Sierra Pacific Industries, Redding, California.). Second, analytical methods differ, ranging from using Jolly-Seber estimators with capture-recapture data to simple counts. Third, I think Table 1 should be split into density estimates from early years (e.g., Franklin et al 1990, Tanner & Gutierrez 1995, Thome et al. 1999) versus later years (e.g., GDRC 2015, MRC 2014, etc.) because of declines in spotted owl populations in the intervening years. In addition there seemed to be some errors in reporting units. For example:
 - GDRC (2015) reported their densities as number of owls/1000 acres and not in km^2 . In Table 1 of the report, this should be corrected to 0.042 owls/ km^2 for the northern portion and 0.192 owls/ km^2 for the southern portion. The difference between these estimates and Diller and Thome (1999) probably reflect changes in the owl population on GDRC due to either habitat loss or presence of barred owls.
 - I did not have access to Roberts et al. (2015) (cited in Table 1) but based on information from Sierra Pacific Industries (2013; citation above) for Trinity County, 0.137 owls/ km^2 seemed more realistic as an upper estimate, which I calculated using 48 activity centers (unrealistically assumed all occupied by pairs = 96 owls) in an area of 701.38 km^2 (173,316 acre survey area).

- HRC 2013 reported a current density of 0.86 owls/mi² of area surveyed, which translates to 0.86 owls/2.59 km² or 0.33 owls/km². I think the problem here was that estimates were multiplied rather than divided by the conversion factor.

Correction of some of these errors will reduce the amount of variability, which may be reduced further if estimates are stratified by time.

2. The term “modeling” is often used to describe various research outputs. I think use of this term tends to be confusing to most readers because models are often construed as simulation models that generate hypotheses rather than statistical models where inferences can be made from results based on empirical data. For example, statements such as “Franklin et al. (2000) conducted a modeling effort in northwestern California to explain variation in both apparent survival and reproductive output” implied that simulation models were used rather than statistical models that were actually used. It would be more appropriate instead to state “Franklin et al. (2000) analyzed variation in both apparent survival and reproductive output in northwestern California”, which puts it in the context of empirical data being analyzed rather than a simulation model. On the other hand, Schumaker et al. 2014 relied less on empirical data and more on simulation of population processes. In this paper, I would argue they generated hypotheses rather than concrete inferences about northern spotted owl populations.
3. The *Home Range and Territoriality* subsection could have been synthesized much better, especially since there is a plethora of home range studies for California. For example, the following studies (not an exhaustive list) should have been included in Table 2:
 - Zabel, C. J., K. McKelvey, and J. P. Ward, Jr. 1995. Influence of primary prey on home-range size and habitat-use patterns of northern spotted owls (*Strix occidentalis caurina*). *Canadian Journal of Zoology* 73:433-439
 - Bingham, B. B., and B. R. Noon. 1997. Mitigation of habitat “take”: application to habitat conservation planning. *Conservation Biology* 11:127-138.
 - Solis, D. M., and R. J. Gutierrez. 1990. Summer habitat ecology of northern spotted owls in northwestern California. *Condor* 92:739-748.
 - Sisco, C. L. 1990. Seasonal home range and habitat ecology of spotted owls in northwestern California. MS Thesis. Humboldt State University, Arcata, California.

I would focus more on home range size in California than on other parts of the owl’s geographic range, except possibly in southern Oregon where geographic provinces overlap with northern California.

4. I thought that the information under the *Habitat Requirements* subsection could have been synthesized better and more focused on northern spotted owls in California (while “borrowing” some relevant information from studies in the same physiographic provinces in southern Oregon). There is a large amount of literature on northern spotted owls in California and I thought this could have been used more effectively. In particular, I thought this section could be improved by:
 - Restructuring habitat use and quality around primary prey use by spotted owls (e.g., dusky-footed woodrats and other early seral species versus northern flying squirrels and other older forest prey species) in the different physiographic provinces in California.
 - I think separate descriptions of Nesting & Roosting Habitat and Foraging Habitat were somewhat misleading because it is the juxtaposition and mosaic of these different seral stages that define spotted owl habitat, at least in some parts of their range. This was mentioned in this section but I would focus on the landscape level structure found in the various studies (e.g., Franklin et al 2000, Olson et al. 2004) first, which would then provide the basis for describing the separate, inter-connecting components.

- Most, if not all, of the study area in Dugger et al. 2005 was in the Eastern Cascades Physiographic province (the South Cascades Study Area in your Figure 7, which should be compared with the physiographic provinces in your Figure 6). Comparing this study with the studies in the CA Coast and CA Klamath are a little misleading because the diet of northern spotted owls in the OR Eastern Cascades is dominated by northern flying squirrels (38.9%) and much less by woodrats (8.2%; see Table 2 in Forsman, E. D., R. G. Anthony, E. C. Meslow, and C. J. Zabel. 2004. Diets and foraging behavior of northern spotted owls in Oregon. *Journal of Raptor Research* 38:214-230). This suggests that prey may be driving the differences between Dugger et al. 2005, Olson et al 2004 and Franklin et al. 2000. For example, dusky-footed woodrats (associated with early seral stages) predominated in the diet of owls in the Franklin et al. 2000 study but less so in Olson et al 2004 and much less so in Dugger et al. 2005 (see Forsman, E. D., R. G. Anthony, E. C. Meslow, and C. J. Zabel. 2004. Diets and foraging behavior of northern spotted owls in Oregon. *Journal of Raptor Research* 38:214-230). Comparisons among these three studies (e.g., Table 4) should keep the differences in northern spotted owl prey composition in mind. The Dugger et al 2004 study would be useful in describing habitat in the California Cascade Province since it is just north of the California border.
- A couple of overview papers that tried to put the issue of spotted owl habitat fragmentation and heterogeneity into context (not included in the Status Review) were:
 - Franklin, A. B., and R. J. Gutiérrez. 2002. Spotted owls, forest fragmentation, and forest heterogeneity. *Studies in Avian Biology* 25:203-220.
 - Franklin, A. B., B. R. Noon, and T. L. George. 2002. What is habitat fragmentation? *Studies in Avian Biology* 25:20-29.
- One problem I had with Table 3 is that it pooled together a number of studies that were based on different scales (e.g., foraging locations vs territory scale) and that based the inferences on different metrics (use vs occupancy vs demographic performance). I would separate out studies based on these differences.

STATUS AND TRENDS IN CALIFORNIA SECTION

General Comments

1. While interesting, the Schumaker et al (2014) paper provides more hypothetical than actual empirical scenarios concerning range-wide populations and source-sink dynamics. Because it is a complex, simulation model, there are a number of assumed population processes concerning movement, vital rates, density-dependence, and environmental and spatial variation. While the results from this study provide quantitative and testable hypotheses, I don't think much can be inferred from the results of this exercise in an empirical sense. For example, I think classification of the CA Klamath as a source and the other CA provinces as sinks is a testable hypothesis but lacks empirical support because it is based on a simulation model with assumed population processes. I would make sure this is reflected throughout this section.
2. When discussing rates of population change (λ), you have to be careful about acknowledging how it was estimated. In early studies (including the early meta-analyses), λ was estimated using deterministic Leslie projection matrices that did not account for immigration (only for emigration since apparent survival accounted for this). In later years, the Pradel reverse-time Jolly-Seber (RJS) estimator (termed λ_{RJS} , λ_t , or λ_i) was used that allowed for estimation of annual λ directly from the capture-recapture data, which also could be expressed as a mean λ across years. The RJS estimator did account for immigration in the form of recruitment into the territorial population as well as annual variation in λ . The two different estimators (Leslie matrix

vs RJS) are not really comparable because of the way recruitment was dealt with (e.g., poorly or not at all in the Leslie matrix estimates). I would argue the estimates for λ_{RJS} are more appropriate with minimal bias.

3. You need to be careful about making comparisons of mean λ estimates between the different meta-analyses because the data are not independent (i.e., the same data are used in the beginning years for each of the estimates). I would focus on the most recent estimates rather than trying to infer trends through comparisons with previous estimates.
4. The primary components of λ_{RJS} (the estimates reported in more recent meta-analyses) are apparent survival (which accounts for true survival and emigration from study areas) and recruitment (which accounts for fecundity, juvenile survival and immigration from outside the study area). Thus, fecundity is only part of recruitment in estimating λ_{RJS} although it was a major component in estimating λ using the deterministic Leslie projection matrices, which are no longer considered an appropriate estimator.
5. In terms of the sensitivity of λ to the different vital rates, the influence of adult survival reported by Noon and Biles (1990), Lande (1991), Blakesley et al. (2001) was based on using deterministic Leslie projection matrices, which some would argue is more model sensitivity than what the population is actually most sensitive to. Franklin et al. (2000) argued that annual survival, which exhibited little annual variation, served as the baseline for λ while recruitment accounted for most of the annual variation in λ . Thus, population declines can be a function of both lower recruitment and survival. This is an important point to consider when evaluating the results of the most recent meta-analysis.
6. Under the occupancy section, a number of reasons are given as to why occupancy may not mirror population trends. However, if estimated correctly, it should mirror estimates of λ_{RJS} (but not estimates of λ from Leslie matrices; see my points above) even if floater populations are masking declines observed in the territorial population. This is because recruitment is an important component of both occupancy and λ_{RJS} . It should also be noted that while occupancy can provide valuable information, information on the vital rates provides a clearer picture of potential mechanisms for the decline (i.e., which vital rate is being affected and is contributing most to the population declines).

EXISTING MANAGEMENT SECTION

Because much of this section was outside my area of expertise, I did not have many comments.

General Comments

1. I thought the analysis of THP's was very interesting but one question I had was whether the spotted owl activity centers examined were occupied or not (or what proportion were occupied). This would seem important to the analysis especially when considering post-harvest effects.

THREATS (FACTORS AFFECTING ABILITY TO SURVIVE AND REPRODUCE) SECTION

General Comments

1. Under the *Assessing Habitat Loss through Implementation of the Northwest Forest Plan* subsection, I would argue that dispersal habitat is the least understood of all the habitat components used for management, especially since it has not been linked well with survival of dispersing juveniles, although Miller et al. (1997) did provide some data with limited sample sizes. You might want to acknowledge that here as well as in the Biology and Ecology of The Northern Spotted Owl section.

2. Under the *Timber Harvest* subsection, I think it needs to be acknowledged that Clear Cut harvesting, at least in the CA Klamath province, may not always be negative but could be beneficial if done at smaller scales based on Franklin et al. (2000), Olson et al. (2004), and the following:
 - Sakai, H. F., and B. R. Noon. 1993. Dusky-footed woodrat abundance in different-aged forests in northwestern California. *Journal of Wildlife Management* 57:373-382.
 - Whitaker, D. A. 2003. Relation of thin and release timber management practices to abundance of woodrats, chipmunks, mice, and ticks within the Hoopa Valley Indian Reservation. MS. Humboldt State University, Arcata, California.
3. Under the *Harvest of Hardwood Forests* subsection, a key consideration is that large hardwoods are an important component of mature forests used by northern spotted owls in California (see Solis & Gutierrez (1990)), as well as in early seral stages that support woodrat populations. This was probably not emphasized enough in the Habitat subsection of the Biology and Ecology of The Northern Spotted Owl section (especially Table 3) but hardwood management is probably just as important as conifer management on the landscape.
4. Under the *Wildfire* subsection, I am not sure how relevant the Bond et al. (2009) study on California spotted owls in the Southern Sierra Nevada is to northern spotted owls in California because of differences in fire regimes, vegetation composition and prey species. Although the paper does provide interesting insights and should be discussed, it should be noted that only 1-12% of the foraging sites were in high severity burns with the majority of foraging sites in unburned and low-moderate severity burned areas (see their Table 1). Another concern I had with the Lee et al (2012) study was that it was, again, on California spotted owls in the Sierra Nevada but also that it was a retrospective study using data collected by the U.S. Forest Service, which was not explicitly designed to be used for occupancy modelling. I think they dealt with this well but it does have some methodological problems that a prospective study can avoid. I think the primary focus of this section should be on the Clark et al. studies which seem to be more relevant because they were prospective studies on northern spotted owls in similar provinces to those in California. I think this section is important and should focus primarily on:
 - Acute (short-term) versus chronic (long-term) effects. Some of the differences in the studies examined in this subsection may have been due to different time periods post-fire that were examined. Further clarification of effects might be possible if studies are separated out by acute versus chronic effects.
 - Effects of low-moderate versus high severity fires. The discussion on these effects are sprinkled throughout the subsection but it would be more instructive to focus on the effects across studies rather than study by study.
5. Under the *Climate Change* subsection, I thought the analysis on potential climatic impacts conducted by the Department would have been better analyzed as long term trends using time-series analysis (e.g., over past 100 years or when historic precipitation and temperature data were available). My concern here is that the 2010-2014 time period may have been a short-term variant that did not adequately capture the long term trend in these data.
6. Under the *Sudden Oak Death Syndrome* subsection, I think it needs to be emphasized more clearly what the impacts on northern spotted owl habitat will be with large-scale die-off of tanoaks and other affected hardwood species. First, it could affect mature forests used by owls where tanoak and other hardwoods are a major structural component, including contributing to overall canopy cover. Second, it could affect early seral stage prey species, such as woodrats, by eliminating both cover and forage (both mast and leaves). These points are made but are largely scattered throughout this subsection rather than being emphasized as major concerns. The Holland et al. (2009) study was referenced only by a conference paper abstract and it was

unclear whether the greater tree mortality was due to sudden oak death or more underlying causes.

MANAGEMENT RECOMMENDATIONS SECTION

General Comments

1. Under the *Planning and Timber Practices* subsection, I think the Department needs to seriously considering using an adaptive management approach to better manage spotted owl habitat and to understand whether current practices are working or where they can be improved (see Williams, B. K., and E. D. Brown. 2012. Adaptive management: The U.S. Department of the Interior Applications Guide. Adaptive Management Working Group, Washington, DC.). This approach would include, for example, post-THP monitoring to assess whether harvested sites remain occupied and what levels of harvest render them unoccupied
2. Under the *Population Trend and Demographic Parameters*, item 10 (develop predictive modeling methodology for estimating NSO occupancy) is already available and can easily be adapted (see Bailey, L. L., D. I. MacKenzie, and J. D. Nichols. 2014. Advances and applications of occupancy models. *Methods in Ecology and Evolution* 5:1269-1279 for an overview)
3. Under the *Wildfire* subsection, item 18 should also include survival and reproduction, not just occupancy.
4. Under the *Disease and Contaminants* subsection, I would put item 33 as the lowest priority or delete as a recommendation because most of the available information suggests this is not much of an issue.

Comments from Betsy Glenn

From: [Betsy Glenn](#)
To: [Clipperton, Neil@Wildlife](mailto:Clipperton.Neil@Wildlife)
Cc: [Battistone, Carie@Wildlife](mailto:Battistone_Carie@Wildlife); [Miner, Karen@Wildlife](mailto:Miner_Karen@Wildlife)
Subject: RE: Northern Spotted Owl Status Review - External Peer Review
Date: Wednesday, October 07, 2015 10:37:41 AM
Attachments: [image001.jpg](#)
[NSO_SR_external_peer_review_Final_8Sept2015_EMGReview.docx](#)

Dear Neil and Carie,

Thank you for the opportunity to review the Status Review of the Northern Spotted Owl in California. Overall, I found this to be a very comprehensive, well-written summary of current knowledge of northern spotted owl population status, habitat conditions, and threats to the species' recovery both range-wide and within California.

Because I am not all that familiar with Forest Practices Rules in California, nor with the specifics of the numerous HCPs and SHA in California, I focused my review on the more scientific aspects of your paper (population status, habitat trends, competition with barred owls, etc.).

My one major concern is that in the Summary of Listing Factors section (starting on p. 152), you do not make any specific statements about your conclusions regarding the listing factors. You basically just restate the science you presented earlier in the paper. NSO populations have declined 50-80% over the past 2 decades despite implementation of the NW Forest Plan. The annual rate of decline across the range of the species (approximately 3.9% at of 2014) is severe. Habitat on private lands has been and continues to decline. Habitat on federal lands is somewhat more secure, but faces threats from wildfire and climate change. Barred owls are having significant negative impacts on spotted owls and are present across the entire range of the NSO. As a scientist, I believe that the northern spotted owl currently is at risk of becoming extinct in all or a significant portion of its range. NSOs in California are doing somewhat better than those further north, but the most recent metaanalysis indicates that CA populations are starting to show the severe declines that were observed in the OR/WA populations in the mid 2000s. This may influence what you decide to recommend for listing for California; however, you have more than sufficient data to make informed recommendations about each of the listing factors.

I have provided comments and some minor technical edits in track changes in the attached document (Figures all look good- no edits on those). I also provided some specific recommendations for revising the Summary of Listing Factors section to improve its effectiveness. Again, I think this is a very well-written document that can be improved with some minor revisions. Congrats!

Regards,

Betsy Glenn
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STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
NORTHERN SPOTTED OWL
(*Strix occidentalis caurina*) IN CALIFORNIA



CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
EXTERNAL REVIEW DRAFT, September 8, 2015



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Comment [A1]: Note to external reviewers:
These appendices will be added later.

Acknowledgments (to be completed after external review)

This report was prepared by: Neil Clipperton and Carie Battistone

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**Report to the Fish and Game Commission
A Status Review of the Northern Spotted Owl in California
EXTERNAL REVIEW DRAFT, September 8, 2015**

Executive Summary

[TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]

Regulatory Framework

Petition Evaluation Process

A petition to list the Northern Spotted Owl as threatened or endangered under the California Endangered Species Act (CESA) was submitted to the Fish and Game Commission (Commission) on September 7, 2012 by the Environmental Protection Information Center. A petition evaluation report was prepared by the Department of Fish and Wildlife (Department) and submitted on February 14, 2013, to assist the Commission in making a determination as to whether the petitioned action may be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & (e)).

The Department's charge and focus in its advisory capacity to the Commission is scientific. A petition to list or delist a species under CESA must include "information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The Petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and other factors the Petitioner deems relevant" (Fish & G. Code, § 2072.3). Given this charge the Department recommended to the Commission that the petition be accepted.

Status Review Overview

The Commission published findings of its decision to advance the species to candidacy on December 27, 2013, triggering a 12-month period during which the Department conducted a status review to inform the Commission's decision on whether to list the species. Per Fish & G. Code, section 2074.6, the Department requested a 6-month extension, to allow further analysis and evaluation of the available science, completion of the status review, and peer review process. Due to the extension, Department had a total of 18 months from December 27, 2013 to deliver the status review to the Commission.

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This written status review report indicates, based upon the best scientific information available, whether the petitioned action is warranted, preliminary identifies habitat that may be essential to the continued existence of the species, and recommends management activities and other recommendations for recovery of the species (Fish & G. Code, § 2074.6). Receipt of this report is to be placed on the agenda for the next available meeting of the Commission after delivery. At that time, the report will be made available to the public for a 30-day public comment period prior to the Commission taking any action on the Department’s recommendation.

Existing Regulatory Status

Endangered Species Act

The U.S. Fish and Wildlife Service listed the Northern Spotted Owl as threatened under the Endangered Species Act in 1990. Critical habitat designation occurred in 1992 and was revised in 2008, and a new final rule designating critical habitat was published in December 2012. The first final recovery plan for the Spotted Owl was issued in 2008 and revised in 2011.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act prohibits anyone from taking, killing, or keeping any native bird, its parts, or its nest, without a permit or license. All raptors native to the U.S. are covered by this law. A Special Purpose Possession Permit and/or Endangered Species Permit (depending on species), is required under the Migratory Bird Treaty Act to keep raptors.

California Endangered Species Act

After the Commission voted to accept the petition in December, 2013, the Northern Spotted Owl became a State candidate for threatened or endangered status under the California Endangered Species Act, commencing with section 2050 of the California Fish and Game Code

California Bird Species of Special Concern

The Department currently designates the Northern Spotted Owl as a Species of Special Concern.

Fish and Game Code

The Fish and Game Code includes certain protections for raptors, including the Northern Spotted Owl. Sections applicable to owls include the following:

Section 3503 - It is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.

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298 Section 3503.5 - It is unlawful to take, possess, or destroy any birds in the orders Falconiformes
299 or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird
300 except as otherwise provided by this code or any regulation adopted pursuant thereto.

301 Section 3513 - It is unlawful to take or possess any migratory nongame bird as designated in the
302 Migratory Bird Treaty Act or any part of such migratory nongame bird except as provided by
303 rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory
304 Treaty Act.

305 *California Board of Forestry and Fire Protection*

306 The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire
307 Protection (CAL FIRE) have designated Northern Spotted Owl as a "Sensitive Species" as identified in the
308 California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules).
309 These sections also define Northern Spotted Owl -related terminology, including "activity center",
310 "Northern Spotted Owl breeding season", and "Northern Spotted Owl Evaluation Area." Specific
311 requirements for the disclosure of information on Northern Spotted Owls in the context of timber
312 harvesting, which in all but one case avoid take of Northern Spotted Owl are provided by Forest Practice
313 Rules sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted
314 Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by
315 CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and
316 related activities, would be avoided according to the criteria for determining take avoidance found in
317 Section 919.10. Other language within Section 919 also compels methods to avoid take of Northern
318 Spotted Owl. Sections 919.2 and 919.3 set up protections of bird nests through buffers and avoidance of
319 sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the
320 protections afforded to late successional forests, which are a component of Northern Spotted Owl
321 habitat.

322 *International Union for Conservation of Nature*

323 The International Union for Conservation of Nature Red List of Threatened Species status for the
324 Spotted Owl range-wide is "Near Threatened" because the "species has a moderately small population
325 which continues to decline in northern and western parts of its range."

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Biology and Ecology of the Northern Spotted Owl

Life History

Species Description

The Northern Spotted Owl is a medium-sized dark brown owl, with a barred tail, white spots on its head and breast, and dark brown eyes surrounded by prominent facial disks (Forsman et al. 1993, Gutiérrez et al. 1995). Overall, its length is approximately 46 to 48 centimeters (18 to 19 inches) (Forsman et al. 1993). Males and females are dimorphic in size, with males averaging about 13 percent smaller than females (USFWS 2011a). Males weigh between 430 to 690 grams (0.95 pound to 1.52 pounds), and females weigh between 490 to 885 grams (1.1 pounds to 1.95 pounds) (P. Loschl and E. Forsman pers. comm. 2006 in USFWS 2011a). The Northern Spotted Owl resembles the Barred Owl in appearance, and first generation hybrids of the two species exhibit physical and vocal characteristics of both (Hamer et al. 1994, Kelly and Forsman 2004).

Taxonomy and Genetics

The American Ornithologists' Union recognizes the Northern Spotted Owl as one of three subspecies of Spotted Owls. The two other subspecies are the California Spotted Owl (*S. o. occidentalis*), ranging in the southern Cascade Range of northern California south along the west slope of the Sierra Nevada and in mountains of central and southern California, and Mexican Spotted Owl (*S. o. lucida*) ranging from southern Utah and Colorado south to Michoacán, Mexico. The taxonomic separation of these three subspecies is supported by genetic, morphological, and biogeographic information (Barrowclough and Gutiérrez 1990, Gutiérrez et al. 1995, Haig et al. 2004a, Chi et al. 2005, Henke et al. 2005, Barrowclough et al. 2005, Funk et al. 2008, AOU 2011, Barrowclough et al. 2011). The Marin County population of Northern Spotted Owl is genetically isolated from other Spotted Owl populations in California (Jenson et al. 2006).

There is a narrow, apparently stable zone where hybridization occurs between the Northern and California Spotted Owl in the Southern Cascades and Northern Sierra Nevada Mountains near the Pit River in California (Courtney et al. 2004, Barrowclough et al. 2005). There is evidence in all genetic studies conducted on the species of some genetic mixing of California Spotted Owl into the Northern Spotted Owl range, and fewer examples of the opposite (Courtney et al. 2004). In the Klamath region of California 20.3% of owls were classified as California Spotted Owls (Haig et al. 2004a). Among all Northern Spotted Owls sampled across their range in Oregon, Washington, and California, 12.9% contained California Spotted Owl haplotypes (Haig et al. 2004a). There has been some evidence for genetic flow between Mexican Spotted Owls and Northern Spotted Owls, primarily in Washington, indicating long-distance dispersal of Mexican Spotted Owls most likely via the Rocky Mountain dispersal route (Funk et al. 2008). Until recently, there has been little evidence in the literature of loss of genetic variation and population bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across the range of the Northern Spotted Owl (Washington Cascade Mountains,

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Oregon Cascade Mountains, Oregon Coast Ranges, and Klamath Mountains of Oregon and California) provides compelling evidence that a population bottleneck may have occurred, with more prominent bottlenecks in the Washington Cascade Mountains as compared to other regions in the analysis (Funk et al. 2010).

Since the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two species have resulted as well. The majority of hybrids that have been evaluated with genetic methods have resulted from a cross between a female Barred Owl and a male Spotted Owl (Haig et al 2004b, Kelly and Forsman 2004). First generation hybrids share phenotypic and vocal characteristics of both parent species (Hamer et al. 1994). Second generation hybrids are often difficult to distinguish from Barred or Spotted Owls in the field and genetic testing may be the only sure method of identification (Kelly and Forsman 2004). Both first and second generation hybrids were found to be reproductively viable in some cases (Kelly and Forsman 2004).

Geographic Range and Distribution

The current range of the Northern Spotted Owl extends from southwest British Columbia through the Cascade Range, coastal ranges, and intervening forested lands in Washington, Oregon, and northern California, as far south as Marin County (USFWS 1990). The transition between subalpine to alpine forests marks the upper elevation limit at which Northern Spotted Owls are known to occur (Forsman 1975, Forsman et al. 1984). Prior to the mid-1800s, Northern Spotted Owls are believed to have inhabited most old-growth forests or stands throughout the Pacific Northwest, including northwestern California (USFWS 2011a). Although the overall range is not known to have changed, the Spotted Owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon (USFWS 2011a). Local declines have been observed in many portions of the range (see Status and Trends and Barred Owl sections of this report).

The range has been partitioned into 12 physiographic provinces based on landscape subdivisions with different environmental features (Thomas et al. 1990) (Figure 1). This total range of the Northern Spotted Owl has been estimated to have an extent of 230,690 km² (57 million acres) (USDA and USDI 1994).

The 12 physiographic provinces are distributed across the species' range as follows:

- Four provinces in Washington: Eastern Washington Cascades, Olympic Peninsula, Western Washington Cascades, Western Washington Lowlands
- Five provinces in Oregon: Oregon Coast Range, Willamette Valley, Western Oregon Cascades, Eastern Oregon Cascades, Oregon Klamath
- Three provinces in California: California Coast, California Klamath, California Cascades

In California, the Northern Spotted Owl range runs south as far as Marin County in the Coast Ranges and across the Klamath Mountains of northern California east to the Cascade Range where it meets the range of the California Spotted Owl (*S. o. occidentalis*) near the Pit River (Figure 2). The California Coast

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Province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of national forest lands. The California Klamath Province is between the California Coast Province to the west and the California Cascades province to the east, and is a continuation of the Oregon Klamath province, with a southern boundary at the Clear Lake Basin in the inner Coast Range. The California Cascades province is bounded on the west by the Sacramento Valley and the Klamath Mountains, on the east by the Modoc Plateau and Great Basin, and to the south by the Sierra Nevada Mountains (USFWS 1992, Courtney et al. 2008).

Broad-scale patterns of relative abundance of Spotted Owls are suggested by the distribution of recorded Northern Spotted Owl activity centers across the landscape. An activity center is a known Northern Spotted Owl site documented from survey detections (See Appendix 2 for a more detailed definition of activity center). Lower interior densities of Northern Spotted Owl are acknowledged in the 2011 Recovery Plan (USFWS 2011a), which states, "...the dry forest portion of the Spotted Owl's range hosts a minority of the overall population..." Records from the Department's Spotted Owl Database indicate that generally activity centers occur at lower densities in the drier portions of the interior Klamath and Cascade ranges, compared to the Coastal Range and wetter portions of the Klamath Province (Figure 3). It appears many activity centers within the Coast Province have been documented only beginning in the 1990s. This is likely due largely to increased survey effort by private timber companies following the listing by the federal government rather than an increase in Spotted Owl territories in the Coast Province, although Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property in Humboldt and Del Norte counties that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature (GDRC 2015). Humboldt Redwood Company has also reported an increase in number of sites since 2008, but acknowledges the possibility that the increase may be due to the displacement of Spotted Owls to new sites as a result of increasing numbers of Barred Owls (HRC 2015). Large timber companies in the coastal portion of the range have identified a large number of activity centers on their ownerships, with more than 200 activity centers on some ownerships. Consistent with the general pattern, private ownerships in the interior have lower densities of Northern Spotted Owls, but some timber companies still host close to a hundred activity centers (Calforests 2014). Caution must be used when examining these data; activity center sites do not represent the actual number or density of owls across the range in California due to the nature the data are collected and reported. Data are often collected inconsistently based on local project-level monitoring needs and not all data is reported to the database. Also, activity centers are generally retained in the database over time regardless of annual occupancy status (see Status and Trends section of this report).

Reproduction and Development

The Northern Spotted Owl is relatively long-lived with a long reproductive life span (Forsman et al. 1984, Gutiérrez et al. 1995), with wild owls living up to 20 years. Owls are reproductively mature at 1 year of age, but generally do not reproduce for the first time until 2 to 5 years of age. Courtship initiates in February or March, with the first eggs laid in late March through April (Miller et al. 1985, Franklin 1992, Forsman et al. 2002). Timing of breeding onset varies by latitude and elevation, with delayed nesting

Comment [EMG2]: I would start this section with a discussion of the variation in NSO home range sizes from north to south. This is well-documented, and has been related to differences in prey availability and forest conditions on a north-south gradient. The observed patterns in relative abundance are closely tied to the differences in home range size.

Important points:

1. NSOs are territorial and generally exclude other NSOs from most of their ranges. Both the distribution of habitat, and the size of areas defended by NSOs strongly influence relative abundance on any given landscape.
2. Home ranges are larger in areas where northern flying squirrels are the primary prey relative to areas where woodrats are abundant.
3. Site occupancy is not necessarily an indication of population trend. Areas that remain occupied over time may actually be sinks if barred owl densities are preventing successful reproduction/recruitment by NSOs.

Comment [EMG3]: Yes – activity centers are not reflective of population status or even density on particular landscapes for the reasons you have stated (survey effort, variation in detection probabilities, accessibility, etc.). As I mentioned previously, I think this paragraph would be most effective by describing variation in home range sizes across the species' range, and then discussing data on numbers of observed activity centers.

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occurring at higher elevations and latitude (Forsman et al. 1993). Females typically lay 1 to 4 eggs per clutch, with 2 eggs per clutch most common (Forsman et al. 1984, USFWS 1990, Anthony et al. 2006). Incubation, performed exclusively by the female, lasts about 30 days (Courtney et al. 2004). Brooding is almost constant for the first 8 to 10 days and is also done exclusively by the female, after which the female will take short trips off of the nest to hunt (Courtney et al. 2004). The male provides all the food to the nest during incubation and the first 10 days of brooding (Courtney et al. 2004). Chicks fledge from the nest in late May or in June and continue to be dependent on their parents into September until they are able to fly and hunt for food on their own (Forsman et al. 1984, USFWS 1990). Adults can typically be found roosting with young during the day for the first few weeks after they leave the nest, after which adults typically only visit their young during the night to deliver food (Forsman et al. 1984). By November, most juveniles begin to disperse (Miller et al. 1997, Forsman et al. 2002, Courtney et al. 2004).

Most Spotted Owls do not breed every year, but more normally breed every other year (Forsman et al. 2011). The reason for this biennial breeding pattern is unknown, but may be due to the large time investment and energy cost to produce young (Forsman et al. 2011). Annual variation in reproductive success is thought to be related to weather conditions and fluctuations in prey abundance, but may also be related to individual variation, age, and habitat quality within the territory (Forsman et al. 1993, Forsman et al. 2011). Small clutch size, temporal variation in nesting and nest success, and long onset of breeding maturity all contribute to low fecundity for the Northern Spotted Owl (Gutiérrez 1996).

Density

Density (i.e., number of individuals per unit of area) estimates for Northern Spotted Owl are difficult to obtain due to the level of effort required to survey all potential habitat in a given area. Density has been estimated for specific study areas, but not across the species' entire range; several estimates of density are available from sites in California (Table 1). Franklin et al. (1990) estimated crude density (territorial owls/km²) of owls in the Willow Creek Study Area, Humboldt County, at 0.235 owls/km² (95% CI = 0.214-0.256), and ecological density (number of individuals/ km² of habitat) at 0.544 owls/km² (95% CI = 0.495-0.592) and 0.660 owls/km² (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km². Diller and Thome (1999) estimated crude density for owls in their northern California coast study area in Humboldt, Trinity and Del Norte counties to be 0.092 owls/km²±0.006, 0.351 owls/km²±0.011, and 0.313 owls/km²±0.017 for Klamath, Korbelt and Mad River regions respectively, with an overall mean density of 0.209 owls/km²±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbelt, and Mad River respectively (Diller and Thome 1999). The 2015 annual report for Green Diamond Resource Company Northern Spotted Owls Habitat Conservation Plan (GDRC 2015) notes a density of 0.17 owls/km² in the northern portion of their land in Humboldt County, and 0.78 owls/km² in southern portions. Sierra Pacific Industry reported 0.450 owls/km² between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km² between 2011 and 2013 on their lands in Trinity, Siskiyou, Shasta, Modoc and Lassen counties (Roberts et al. 2015). In Mendocino County, Mendocino Redwood Company reported a density of 1.89 occupied territories/km² of area surveyed (MRC 2014). Lastly, Humboldt

Comment [EMG4]: Yes, density is hard to estimate for NSOs. Why are you interested in it? It is an important factor to consider when developing conservation strategies; however, it's not clear (given the uncertainties associated with it) why it is important to you. What are you trying to convey to your readers?

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Redwood Company (HRC) reported 1.22 occupied territories/km² and 2.23 owls/km² of area surveyed on their lands in Humboldt County (HRC 2013).

Table 1. Density estimates for Northern Spotted Owls within various study areas throughout the range in California.

Source	Density Measure	Location
Franklin et al. 1990	0.235 territorial owls/km ² 0.544 number of owls/ km ² of habitat 0.660 number of owls/ km ² of habitat	Willow Creek Study Area in Humboldt County
Tanner and Gutiérrez1995	0.219 owls/km ²	Redwood National Park in Humboldt County
Diller and Thome 1999	0.092 owls/km ² (Klamath) 0.351 owls/km ² (Korbel) 0.313 owls/km ² (Mad River) 0.209 owls/km ² (mean)	Northern California coast study area in Humboldt, Trinity and Del Norte counties
GDRC 2015	0.170 owls/km ² (northern) 0.780 owls/ km ² (southern)	Green Diamond Resource Company land in Humboldt County
Roberts et al. 2015	0.450 owls/km ² between 1989 and 2003 0.450 owls/km ² between 2003 and 2007 0.459 owls/km ² between 2011 and 2013	Sierra Pacific Industry lands in Trinity, Siskiyou, Shasta, Modoc and Lassen* counties
MRC 2014	1.89 occupied territories/km ² of area surveyed	Mendocino Redwood Company in Mendocino County
HRC 2013	1.22 occupied territories/km ² of area surveyed 2.23 owls/km ² of area surveyed	Humboldt Redwood Company in Humboldt County

Comment [EMG5]: I'd put LOCATION as the first column and SOURCE as the last column. Most readers are more interested in location rather than who did the study.

* Densities were reported for Modoc and Lassen counties in this study; however these counties are not within the range of the Northern Spotted Owl. Sierra Pacific Industry lands in this study overlap with the Northern Spotted Owl and California Spotted Owl ranges.

As apparent from the reports of density estimates above, there is considerable variation among studies even though most studies occurred within the coastal forests. This variation in density may be attributed to habitat availability, habitat heterogeneity, territoriality, weather patterns, and presence of Barred Owls (Franklin et al. 1990, Diller and Thome 1999, Courtney et al. 2004 Sovern et al. 2014). Another possible explanation of the variation is that data collection and analysis varied among the studies. Given this, it is nearly impossible to extrapolate density across the entire California range for Northern Spotted Owl.

Comment [EMG6]: So...is density an important factor to consider when conducting this status review ? (I'd say "no," but you should state that clearly).

Hunting and Food Habits

As described in Forsman et al. (1993), Northern Spotted Owls are sit and wait (e.g., perch and pounce) predators. They mostly hunt during nighttime hours (i.e., nocturnal), but will forage during the day as well (Forsman et al. 1984, Sovern et al. 1994, Forsman et al. 2001). Generally, flying squirrels are the main component of the diet in Douglas-fir and western hemlock forest within the northern portion of the owl's range (in Washington and Oregon); whereas in the southern portion of the range (Oregon

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497 Klamath, California Klamath, and California Coastal Provinces) dusky-footed woodrats are the main
498 component of the diet (Forsman et al. 1984, 2001, 2004, Zabel et al. 1995, Ward et al. 1998, Franklin et
499 al. 2000, Hamer et al. 2001, Dugger et al. 2005). Other prey items seen in the owl's diet in smaller
500 proportions include deer mice, tree voles, red-backed voles, gophers, snowshoe hare, bushy-tailed
501 woodrats, small to medium sized birds, bats, and insects (Forsman et al. 1984, 2001, 2004, Ward et al.
502 1998, Hamer et al. 2001). A study within the Southern Cascades and Klamath Provinces in California
503 (Timber Products Company timberland) identified 16 species of mammals, 5 species of birds, and 1
504 species of insect among 224 pellets collected, with major prey items being 58.3% woodrat sp., 29.2%
505 Northern flying squirrel, 3.9 % broadfooted mole, 3.9% rabbit and 1.4% gopher (Farber and Whitaker
506 2005).

507 Diet analysis conducted in Washington during the fall and winter months indicated seasonal variation in
508 prey species consumed as a function of the availability of the owls preferred prey species during various
509 portions of the year (Forsman et al. 2001). In the Washington study area, flying squirrels were more
510 prevalent in the diet during fall and winter months, whereas prey species that hibernated or spent the
511 winter under the snow (e.g., chipmunks and pikas) were missing from the diet during the same period.
512 During the spring, summer and early fall months consumption of insects, gophers, and snowshoe hares
513 occurred more frequently (Forsman et al. 2001). Forsman et al. (2001) noted that diets varied among
514 territories even within the same forest type with much of the variation attributed to differences in
515 spatial abundance of prey, but other factors, such as individual preferences, experience, prey
516 accessibility, or timing of pellet collection, may have played a role. While the populations in California
517 are geographically distinct, and hunting and food habits may differ somewhat from owls in Washington,
518 Northern Spotted Owls in California likely vary diet seasonally according to the spatial distribution and
519 abundance of their preferred prey.

520 Metabolic measurements made on California Spotted Owls in Weathers et al. (2001) showed very low
521 basal metabolic rates compared to other owl species, thereby leading to very low energy requirements.
522 Field metabolic rate on adults actively caring for young averaged only 34% of the metabolic rate
523 predicted for other avian species of the same size (Weathers et al. 2001). Considering this low metabolic
524 rate, Weathers et al. (2001) found that, on average, owls can meet their energy requirements by
525 consuming one northern flying squirrel every 1.8 days or one woodrat every 3.7 days. This low metabolic
526 requirement is likely similar to that of Northern Spotted Owls, though no known study has been
527 conducted on this subspecies.

528 There is strong evidence that prey abundance and availability affect selection and use of habitat and
529 home range size of Northern Spotted Owls across their range (Zabel et al. 1995). In northwest California,
530 Northern Spotted Owls were found to forage in areas where the occurrence of prey was more
531 predictable, within older forests, and near ecotones of old forest and brush seral stages (Ward 1990 as
532 cited in USFWS 2011a). Owls tend to select old-growth forests with less edge habitat and have larger
533 home ranges when flying squirrels are the dominant prey, whereas they tend to select variable-aged
534 stands with more edge habitat when woodrats are the dominant prey (Courtney et al. 2004). In these
535 variable-aged stands, older forests remain an important component of nesting and roosting habitat.

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Where woodrats are the dominant prey, the amount of edge between older forests and other habitat types in Oregon was found to have a positive effect on foraging success and subsequent reproductive success due to increased prey availability (Olson et al. 2004). Where woodrats are the primary prey item, young seral stages often provide high quality prey habitat but provide limited foraging opportunities for Spotted Owls due to a lack of perches from which to hunt or to prey inaccessibility in the dense undergrowth; however, when young seral forests are adjacent to older forest stands surplus woodrats may disperse into these older forests making them more vulnerable to predation by Spotted Owls (Meyer et al. 1998, Franklin et al. 2000, Zabel et al. 2003, Olson et al. 2004). In the northwestern California coast redwood zone and the mixed conifer forests in the interior of the California range near Yreka, California, studies have shown that Spotted Owls will forage in recent harvest-created hardwood and shrub habitat (i.e., within 6-30 year old clearcuts) that contain woody debris, scattered conifers and snags, and that are adjacent to older forests (Irwin et al. 2013). Winter use of these areas was more pronounced in areas with 9-18 m²/ha basal area (Irwin et al. 2013).

Home Range and Territoriality

Northern Spotted Owls are territorial. Territories are actively defended using aggressive vocal displays, and even physical confrontations on the rare occasion (Courtney et al. 2004). Because of their high territoriality, broadcast surveys are generally a very effective method for determining presence of Spotted Owls (Courtney et al. 2004); however, calling may be suppressed by the presence of Barred Owls (see Barred Owl section of this report). Territory size for Northern Spotted Owls varies depending on the setting and structure of the habitat (e.g., canopy closure, understory composition, and slope), number of available nesting and roosting sites, and location relative to suitable foraging habitat (Courtney et al. 2004). In general, Spotted Owls have a broad home range with a centrally located nest and roosting site. For this reason, Spotted Owls are considered central place foragers during the breeding season when they are tied to a central nesting or roosting site. Spotted Owls often occupy a home range that is larger than the core use area, and may use an area that is larger than the portion of the home range which is defended (i.e., home ranges may overlap with that of other Spotted Owls). Northern Spotted Owl home ranges generally have a greater amount of older forest near the nest and within the core area use, and more diverse forest types and ages on the periphery of their ranges (Swindle et al. 1999).

Estimates of annual home range size vary across the Northern Spotted Owl's range. The 1990 Conservation Strategy for Northern Spotted Owls (Thomas et al. 1990) reports median annual home range size of owl pairs in various study areas throughout the species' range. Table 2 summarizes home range estimates across the range of the Northern Spotted Owl. Home range estimates from various studies are reported using different analytical tools (e.g., Minimum Convex Polygon, Modified Minimum Convex Polygon, Fixed Kernel, and Adaptive Kernel) and are identified as such in Table 2. Median home range sizes in Oregon and Washington varied from a low of 1411 acres in the mixed conifer forests of the Klamath Mountains (South Umpqua) to a high of 9930 acres in Washington's Olympic Peninsula, consisting mostly of western hemlock with Douglas-fir (Thomas et al. 1990). More recently, Schilling et al. (2013) documented considerably smaller home range sizes in southwestern Oregon's mixed conifer

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575 forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference
576 between breeding and nonbreeding seasons. The study showed core area size, annual home range and
577 breeding home range size increased as amount of hard edge increased (Schilling et al. 2013). In their
578 study site in the dry forests of the eastern Cascades in Washington, Forsman et al. (2015) found
579 considerable difference between breeding home range and non-breeding home range, with ranges
580 being 3.5 times larger during the fall and winter months.

581 Home range of Northern Spotted Owls may overlap with those of other neighboring owl pairs,
582 suggesting that the defended area (i.e., territory) is smaller than the area used for foraging (Forsman et
583 al. 1984, Solis and Gutiérrez 1990, Forsman et al. 2015). Northern Spotted Owl home ranges are larger
584 where flying squirrels are the predominant prey, in the northern portion of the range, and smaller
585 where woodrats are the predominant prey, in the southern portion of their range (Zabel et al. 1995,
586 Forsman et al. 2001). Woodrats provide twice the biomass of flying squirrels and therefore are more
587 energetically favorable, which likely explains the smaller home range in the owl's southern portion of
588 the range (Ward et al 1998, Franklin et al. 2000). The portion of the home range used during the
589 breeding season can be significantly smaller than that used in the remainder of the fall and winter
590 (Forsman et al. 1984, Sisco 1990 as cited in USFWS 2011a, Forsman et al. 2015). Forsman et al. (2015)
591 attributes the larger winter home range to prey dynamics and exploratory excursions in search of better
592 habitat.

593

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594 **Table 2.** Summary of annual home range and core home range sizes across the range of the Northern Spotted Owl. MCP = Minimum Convex Polygon, MMCP =
595 Modified Minimum Convex Polygon, FK = Fixed Kernal, and AK = Adaptive Kernal.

Area	Annual Home Range in hectares (+/- one Standard Error)				Core area in hectares	Source
	MCP	MMCP	95% FK	95% AK		
Oregon Coast	1569(463)	1018(160)				Carey et al. 1992
Oregon Coast	1108(137) to 2214(357)		842(115) to 1344(247)		87(6) to 100(5) 95% FK	Glenn et al. 2004
Oregon Coast	2272 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
Oregon Coast	2586 (median)					Thraikill and Meslow pers comm. (as reported in Thomas et al. 1990)
Oregon Coast	1693 (median)					Carey et al. 1990 (as reported in Thomas et al. 1990)
Oregon Klamath	533(58)	472(43)				Carey et al. 1992
Oregon Klamath			576(75)		94(11) 95% FK	Schilling et al. 2013
Oregon Western Cascades	3066(1080)				417(129) AK	Miller et al. 1992
Washington Eastern Cascades	3419(826)		2427(243)			Forsman et al. 2015
Washington Eastern Cascades	3669(876)					King 1993
Washington Western Cascades	2553 (median)					Various references as reported in Thomas et al. 1990
Washington Olympic Peninsula	4019 (median)					Various references as reported in Thomas et al. 1990
California Klamath	1204 to 1341 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
California Klamath	685 (median)					Solis 1983 (as reported in Thomas et al. 1990)
California Coast	786(145)			685(112)	98(22) 95% AK	Pious 1995

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596 *Dispersal*

597 As discussed above, juveniles begin to disperse in the fall, with a few individuals beginning to disperse in
598 early winter. Juvenile dispersal from the parental territory occurs in stages, as juveniles may temporarily
599 settle in locations for up to 7 months before moving on to another temporary location, which may occur
600 several times before individuals establish a territory of their own (Miller et al. 1997, Forsman et al.
601 2002). LaHaye et al. (2001) found that successful juvenile California Spotted Owls often settled in
602 territories previously used by pairs or single owls, which may suggest that owls were able to use some
603 sort of cues that indicated some value of habitat quality when determining a territory of their own
604 (Buchanan 2004).

605 In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent
606 territory was between 13.5 and 14.6 km (8.4-9.1 mi) for males and between 22.9 and 24.5 km (14.2-15.2
607 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted
608 Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while
609 juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). While the only
610 data available on dispersal pertains to Northern Spotted Owls in Washington and Oregon, and California
611 Spotted Owls in California, we can extrapolate that Northern Spotted Owls in California act similarly,
612 because, while the populations are genetically and geographically distinct, they still share many
613 ecological and behavioral characteristics.

614 Juvenile Northern Spotted Owls experience high mortality rates (>70% in some areas) during dispersal
615 due to a variety of factors including starvation, predation, and vehicle strikes (Miller 1989, Franklin et al.
616 1999, USFWS 1990, Forsman et al. 2002). Habitat type used during dispersal may also have an effect on
617 mortality. Miller et al. (1997) found that the probability of mortality decreased when dispersing
618 juveniles utilized open sapling forests, but increased when clear cuts were utilized. Successful juvenile
619 dispersal likely depends on locating suitable nesting, roosting and foraging habitat in proximity to other
620 occupied sites or among occupied sites (LaHaye et al. 2001), as well as the presence of suitable habitat
621 to disperse through (Miller et al. 1997, Buchanan 2004).

622 **Habitat Requirements**

623 Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western
624 hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and
625 redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally
626 use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al.
627 1990, Carroll and Johnson 2008, Carroll 2010, USFWS 2011); however, younger forest stands with
628 structural components similar to older forests may also be used by Spotted Owls (USFWS 2011a). The
629 edge between old-growth forest and other vegetation types have also been shown to be important
630 habitat components (Franklin et al. 2000).

631 Throughout the Northern Spotted Owl's range in Washington, Oregon, and California, Bart and Forsman
632 (1992) found owls were about 40 times more common in areas with older forest compared to areas

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633 lacking older forest. In Western Oregon, Meyer et al. (1998) determined that random owl sites
634 contained more old-growth forest than random locations on the neighboring landscape. In
635 Northwestern California, Northern Spotted Owls used old-growth with a higher frequency relative to
636 this forest age class' distribution on the landscape, and similarly, used intermediate to young forests
637 with a lower frequency (Solis and Gutiérrez1990 and Thome et al. 1999).

638 Discussions on habitat components below address range-wide knowledge of Northern Spotted Owl
639 habitat, as well as knowledge of owl habitat specific to California. This report addresses habitat
640 requirements with a focus on major geographic provinces in California. When considering the enormous
641 amount of research on Northern Spotted Owl habitat, careful consideration should be given to
642 California-specific research when evaluating habitat requirements for the species in the state, and in
643 forming conservation and management decisions.

644 *Nesting and Roosting Habitat*

645 Habitat selection has largely been evaluated for nesting and roosting habitat by comparing habitat
646 surrounding occupied Spotted Owl sites to randomly selected sites (Solis and Gutiérrez 1990, Bart and
647 Forsman 1992, Hunter et al. 1995, Thome et al. 1999). Descriptions of nesting and roosting habitat were
648 provided in the early- to mid- 1990s (Solis and Gutiérrez 1990, Thomas et al. 1990, Bart and Forsman
649 1992) and have been validated by extensive research across most of the range of Northern Spotted Owl
650 (Gutiérrez et al. 1995, Hunter et al. 1995, Meyer et al. 1998, Lahaye and Gutiérrez1999, Swindle et al.
651 1999, Weathers et al. 2001, Courtney et al. 2004, USFWS 2008a, USFWS 2011a).

Comment [EMG7]: Describe what NSOs use for nesting – e.g. they are cavity nesters that don't build their own nests. Therefore, late successional forest provides broken-topped trees and trees with cavities that serve as nest sites.

652 The following description of nesting and roosting habitat from the Conservation Strategy for the
653 Northern Spotted Owl (Thomas et al. 1990) remains an accurate portrayal of what we know today
654 throughout the range of the owl:

655 "With the exception of recent studies in the coastal redwoods of California, all studies of habitat
656 use suggest that old-growth forests are superior habitat for northern Spotted Owls. Throughout
657 their range and across all seasons, spotted owls consistently concentrated their foraging and
658 roosting in old-growth or mixed-age stands of mature and old-growth trees. Exceptions were
659 found, but even they tended to support the usual observations that spotted owls nested in
660 stands with structures characteristic of older forests....Structural components that distinguish
661 superior spotted owl habitat in Washington, Oregon, and northwestern California include: a
662 multilayered, multispecies canopy dominated by large (>30 inches dbh) conifer overstory trees,
663 and an understory of shade-tolerant conifers or hardwoods; a moderate to high (60-80 percent)
664 canopy closure; substantial decadence in the form of large, live coniferous trees with
665 deformities- such as cavities, broken tops, and dwarf mistletoe infections; numerous large
666 snags; ground cover characterized by large accumulations of logs and other woody debris; and a
667 canopy that is open enough to allow owls to fly within and beneath it."

668 Although this habitat description accurately describes high quality nesting and roosting habitat
669 throughout the range of the Northern Spotted Owl, recent research has shown that Spotted Owls in

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670 California and portions of southwest Oregon use a more diverse set of forest types for foraging. This is
671 described more fully in the Foraging Habitat section of this report.

672 Forested stands with a higher degree of complexity and a high canopy closure are thought to be
673 preferred for nesting and roosting, in part, because they provide protection from predators and thermal
674 exposure (Weathers et al. 2001, Franklin et al. 2000). Hunter et al. (1995) determined nest and roost
675 sites occurred more frequently in mature and old-growth forest in northwestern California (Willow
676 Creek Study Area) relative to availability of these forest types' on the landscape. Both nest and roost
677 sites had similar amounts of mature and old-growth forest types. Whereas sites used for nesting and
678 roosting in the coastal forests of California often contain younger trees than more interior nesting and
679 roosting sites. In the California Coast Province, young redwood forests along the coast have structural
680 complexity similar to that of older forests elsewhere in the Northern Spotted Owl's range. This is due to
681 stump-sprouting and the rapid growth rates of redwoods, together and variable timber management
682 practices (Thomas et al. 1990, Thome et al. 1999, USFWS 2011a, Irwin et al. 2013).

683 Small-scale spatial habitat requirements in the immediate vicinity of the nest are important but not
684 sufficient to support all activities (e.g., roosting and foraging) conducted at the larger spatial scale
685 (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, USFWS 2011a). Consequently, nesting and
686 roosting habitat is often only a small portion of the entire home range (Forsman et al. 1984, Solis and
687 Gutiérrez 1990, USFWS 2011a).

688 To assess the success of the coordinated forest management plan for federal lands, the Northwest
689 Forest Plan (NWFP; see Northwest Forest Plan section of this report), Davis et al. (2011) developed a
690 habitat suitability map for nesting and roosting habitat across the Northern Spotted Owl range (Figure
691 4). The habitat suitability model was developed using MaxEnt model output, including variables for
692 percent conifer cover, average conifer dbh, amount of large conifer (trees >30 in dbh per acre),
693 diameter diversity, average stand height, and average stand age. Much of the highest suitable habitat is
694 within northwestern California (inclusive of the northern most portion of the California Coast Province
695 and the western portion of the California Klamath Province) and along the coastal forests.

696 *Foraging Habitat*

697 Compared to nesting and roosting habitat, foraging habitat occurs over a much larger portion of the
698 Northern Spotted Owl's home range, often quite distant from the nesting or roosting site. Within a
699 Spotted Owl home range, foraging habitat use may vary seasonally, with a larger area and younger
700 forests used in the non-breeding period (Forsman et al. 1984, Solis and Gutiérrez 1990, USFWS 2011a).
701 Overall foraging habitat consists of areas where the prey species occur and are available [for capture by](#)
702 [owls](#) (Ward 1990, Zabel et al. 1995).

703 In California, foraging habitat is generally composed of a more diverse set of forest types and structural
704 characteristics than nesting and roosting habitat. Spotted Owls are difficult to observe during nighttime
705 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and
706 roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry

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studies that document owl locations throughout nighttime movements. Although it is difficult to determine when and where owls are actually obtaining prey, telemetry does provide information on the diversity of forest types used during foraging excursions.

There is a general shift in foraging habitat requirements from north to south within the Northern Spotted Owl range, with foraging habitat in the northern portion of the range being composed of mostly older forests, and in California being composed of a diverse range of forest types from mature to relatively young (USFWS 2009). In the northern portion of the Northern Spotted Owl range where flying squirrels are the dominant prey, foraging habitat may have the same characteristics as nesting and roosting habitat (Gutiérrez 1996, USFWS 2011a). Whereas in the southern portion of their range, where woodrats and voles are the predominant prey species, foraging habitat may include tanoak, oak and younger conifer stands that provide a food source for these prey species (Franklin et al. 2000, USFWS 2009).

Landscape-level analyses in portions of the Klamath Province, where woodrats are the main prey item, suggest that a mosaic of late-successional forests intermixed with various other seral stages may benefit Northern Spotted Owls more than large uniform blocks of older forests (Meyer et al. 1998, Franklin et al. 2000, Zabel et al. 2003). Irwin et al. (2012) found in Oregon and northwestern California that Northern Spotted Owl foraging habitat appeared to be maximized in patches of trees with average quadratic mean diameter¹ of 40 to 55 cm (15-22 inches). Probability of an area being selected for foraging declined rapidly beyond 200 to 300 m (0.12-0.19 miles) from a nest site, yet increased with basal area of hardwoods and with increases in shrub counts (except in areas with high abundance of hardwoods and shrubs).

Within the northern Sierra Nevada Mountains, similar to the mixed conifer Cascade mountain range, Irwin et al. (2007) used radio-telemetry data to assess foraging use parameters of California Spotted Owls. Topography, forest density and heterogeneity, and tree species composition all influenced foraging habitat selection, which in this case was driven by the habitat of the preferred prey, dusky-footed woodrat. Foraging was closely associated with forest stands next to nests and small streams at lower elevations. Intermediate basal area values (35-55 m²/hectares) for Douglas-fir, white fir, and red fir and hardwoods ≥20 cm (≥8 inches) were all positively correlated to foraging habitat use. Owls foraged in sites with an average tree density of 1160 trees/hectare, foraged in stands with 17 large green (>66 centimeter or >26 inch diameter) trees/ha. Use declined with increasing basal area of ponderosa pine. Foraging areas were not strongly associated with roads, slope or aspect.

As noted previously in this report, several studies have shown a benefit of edge habitat for Northern Spotted Owls, as certain habitat types that border older forest may contain higher numbers of preferred prey, the dusky footed woodrat, and surplus prey may venture into older forests that border habitat

¹ Compared to the arithmetic mean, quadratic mean diameter, or QMD, assigns greater weight to larger trees. QMD is always greater than or equal to the arithmetic mean for diameter at breast height for a given set of trees.

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where prey is abundant making them more available to foraging owls (Zabel et al. 1995, Thome et al. 1999, Franklin et al. 2000, Franklin et al. 2013). For instance, Zabel et al. (1995) often found Spotted Owls foraging near transitions between early- and late-seral stage forests stands in northern California, likely where prey species were more abundant or more readily available. Franklin et al. (2000) conducted a modeling effort in northwestern California to help explain variation in both apparent survival and reproductive output. The study found that one of the best models contained a covariate representing the amount of edge between Spotted Owl (defined in the study as mature and old-growth forests with particular characteristics) and other habitats, thereby suggesting that reproductive output and survival are positively influenced by amount of edge, presumably due to increased availability of prey. However, foraging owls have been shown to avoid non-forested areas (e.g., recent clearcuts) and very early forest successional stages (USFWS 2011a, Irwin et al. 2013).

Dispersal Habitat

Generally, it is well accepted that dispersal habitat for Northern Spotted Owls consists of stands with adequate tree size and canopy closure to provide protection from avian predators and that have at least minimal foraging opportunities (Miller et al. 1997, Thomas et al. 1990, Forsman et al. 2002, Buchanan 2004, USFWS 2011a). This may include younger forest stands with less diversity than nesting and roosting habitat, such as even-aged and pole stands, but should at the minimum contain some roosting structures and foraging habitat during this transient stage (Davis et al. 2011, USFWS 2011a). The latest meta-analysis (Forsman et al. 2011) indicates that recruitment of owls into the breeding population likely depends on the amount and quality of dispersal habitat to ensure survival of dispersing owls.

Comment [EMG8]: Dugger et al. (2015) should be available in the next few weeks.

Spotted Owls have been shown to disperse through highly fragmented forest landscapes and seem to use mature and old-growth forests more than that forest type's availability on the landscape during this phase (Miller et al. 1997, Forsman et al. 2002). The USFWS (USFWS 2011) states that corridors of dispersal habitat within fragmented landscapes act to facilitate rapid movement to areas of better habitat. There is little evidence that small openings in forest habitat influence the dispersal of Spotted Owls, but large non-forested valleys may act as barriers to both natal and breeding dispersal (Forsman et al. 2002). Water bodies may also function as barriers to dispersal, but this is not clearly understood (Forsman et al. 2002).

Thomas et al. (1990) suggests juvenile movement corridors need not be provided on the landscape outside of areas managed as nesting and roosting habitat if 50% of the forest measured on a quarter township basis is forested by trees with average diameter >11 inches and >40 percent canopy closure (i.e., the 50-11-40 rule). Regarding this rule, the USFWS Recovery Plan (2011) states, "the minimum levels of this definition describe habitat supporting the transient phase of dispersal."

A clear understanding of dispersal habitat is key to the management of owl habitat across the Northern Spotted Owl's range. Buchanan (2004) stressed the importance of appropriate management of dispersal habitat and suggests that one of the greatest inadequacies of Spotted Owl habitat management is the lack of retention of structurally complex forest components, such as snags and downed woody debris, at the time of or post timber harvest. Additional studies in California, such as radio telemetry on juvenile

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owls, prey abundance and availability, and habitat modeling, are required in order to elucidate specific habitat requirements for and barriers to dispersal.

In an attempt to document the level of change in dispersal habitat, Davis et al. (2011) developed dispersal habitat maps for 1994-2007 using Global Information Systems (GIS), using variables for conifer dbh ≥ 11 inches and conifer cover ≥ 40 percent (Figure 5). The maps also included some amount of nesting and roosting habitat since owls will disperse through these habitat types. Dispersal habitat is continuous in large portions of the northern range in California, with small isolated patches north of Point Arena and in Marin County, in the California Coast Province.

Northern Spotted Owl Habitat Descriptions for Geographic Provinces in California

The forest types within the California range are quite diverse, and consequently, Northern Spotted Owls use the habitat differently among these forest types. Historically the range of the Northern Spotted Owl has been separated into 12 physiographic provinces based on differences in vegetation, soils, geologic history, climate, land ownership and political boundaries (USFWS 2011a; Figure 1); of which three provinces are in California – California Coast, California Klamath, and California Cascade. To better understand the range of forest types used and regional differences that influence habitat quality in California, general owl habitat within each province is described below.

In addition to province segregations, habitat modeling conducted for the 2011 Revised Recovery Plan (USFWS 2011a) identified 11 modeling regions range-wide, five of which occur in California (Figure 6). These modeling regions were developed to capture regional differences in forest environments in acknowledgement of the fact that Northern Spotted Owls exhibit different habitat associations in various portions of their range, and focused on differences in habitat rather than political boundaries or ownership type. For this reason, four of the five modeling regions in California extend into Oregon where similar habitat occurs. Modeling regions that overlap with the California Coast, California Klamath and California Cascade provinces are described below under the appropriate province description.

California Coast Province

A description of the California Coast province is noted below, as defined in the 1992 Northern Spotted Owl recovery plan (USFWS 1992):

“The California Coast province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of national forest lands. The coastal part of the province encompasses the majority of the redwood forest habitat type. Inland forests are Douglas-fir and mixed Douglas-fir/hardwood types, the latter often interspersed with chaparral and grasslands.”

Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) are included in the California Coast Province, the Redwood Coast (RDC) and Interior Coast (ICC) regions. The RDC is described below:

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813 “This region is characterized by low-lying terrain (0 to 900 m) with a maritime climate; generally
814 mesic conditions and moderate temperatures. Climatic conditions are rarely limiting to Spotted
815 Owls at all elevations. Forest communities are dominated by redwood, Douglas-fir-tanoak
816 forest, coast live oak, and tanoak series. The vast majority of the region is in private ownership,
817 dominated by a few large industrial timberland holdings. The results of numerous studies of
818 Spotted Owl habitat relationships suggest stump-sprouting and rapid growth rates of redwoods,
819 combined with high availability of woodrats in patchy, intensively-managed forests, enables
820 Spotted Owls to maintain high densities in a wide range of habitat conditions within the
821 Redwood zone. This modeling region contains the Green Diamond and Marin DSAs [density
822 study areas].” (USFWS 2011a, pg C-9 and C-10).

823 Along the coast of northwestern California young redwood and mixed conifer-hardwood stands appear
824 capable of supporting higher densities of Spotted Owls than younger forests in other regions. This is
825 particularly the case in areas where young hardwood forests provide a multilayered structure (Thomas
826 et al. 1990, Diller and Thome 1999) within a conifer stand. It is important to note here (and is discussed
827 later in the document) that density estimates are not necessarily linked with high quality habitat (i.e.
828 habitat conferring high reproductive success).

829 In young growth coastal forests with a negligible amount of old-growth stands (>200 yr) in Humboldt
830 and Del Norte counties, Thome et al. (1999) found Northern Spotted Owls were positively associated
831 with middle-aged stands (21-40 years-old) that contained larger trees and higher proportions of stands
832 with the largest basal area class (>69 m²/ha), and negatively associated with younger stands that
833 contained smaller trees. Irwin et al. (2013) found that Northern Spotted Owls used patches with more
834 large trees and greater basal area within two study areas in the coastal redwood zone (Fort Bragg and
835 Eureka). It is thought that stump-sprouting and rapid growth rates of redwoods, together with readily
836 available prey (mainly woodrats) and patchy intensively managed stands (e.g., small-patch clearcuts),
837 allows owls to occupy this habitat in higher densities (Thomas et al. 1990, USFWS 2011a). Thome et al.
838 (1999) found that timber management using clearcuts was associated with low reproduction, and
839 therefore recommended clearcuts be restricted to 1.1 km (0.68 mi) beyond the nest site.

840 The ICC differs strikingly from the adjacent coastal redwood region, and is described below:

841 “This region... differs markedly from the adjacent redwood coast region. Marine air moderates
842 winter climate, but precipitation is limited by rain shadow effects from steep elevational
843 gradients (100 to 2,400 m.) along a series of north-south trending mountain ridges. Due to the
844 influence of the adjacent Central Valley, summer temperatures in the interior portions of this
845 region are among the highest within the Spotted Owl’s range. Forest communities tend to be
846 relatively dry mixed conifer, blue and Oregon white oak, and the Douglas-fir-tanoak series.
847 Spotted Owl habitat within this region is poorly known; there are no DSAs and few studies have
848 been conducted here. Spotted Owl habitat data obtained during this project suggests that some
849 Spotted Owls occupy steep canyons dominated by live oak and Douglas-fir; the distribution of
850 dense conifer habitats is limited to higher-elevations on the Mendocino National Forest.”
851 (USFWS 2011a, pg C-12, C-13)

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The southern limit of the owl's range in Marin County (part of the California Coast Province and inclusive of both RDC and ICC regions) contains coast redwood, Bishop pine (*Pinus muricata*) and Douglas-fir forests and mixed evergreen-deciduous hardwood forests (e.g., California bay, tanoak and coast live oak) which are regularly used by Spotted Owls (Jenson et al. 2006, USFWS 2011a). Stralberg et al. (2009) found that owls inhabiting Marin County mixed forests were equally likely to be found in conifer dominated stands as they were to be found in hardwood dominated stands, and were negatively affected by habitat fragmentation, yet there did not seem to be a preference for any one tree species when considering owl nest site occurrence. The higher densities of owls and high reproductive success in Marin County may be an indication of a more generalist nature of Marin owls when it comes to habitat selection and the high abundance of woodrats in this area, in contrast to other areas within the Northern Spotted Owl's range in California (Press et al. 2012). The higher use of nest platforms (rather than nest cavities) in the Marin County population is similar to the ratio seen in other younger aged forests, such as in the eastern Cascade Mountains in Washington (Jenson et al. 2006). LaHaye and Gutiérrez (1999) suggested nest type selection depends on the age of the forest, which is supported for the Marin County population where both logging and fire have resulted in younger-aged forests (Jenson et al. 2006).

California Klamath Province

A description of the California Klamath province is noted below, as defined in the 1992 Northern Spotted Owl recovery plan (USFWS 1992):

"The California Klamath province is between the California Coast province and the California Cascades province. It is a continuation of the Oregon Klamath province, south to the Clear Lake Basin in the inner Coast Range. The area is mountainous and covered primarily with Douglas-fir forests. Mixed Douglas-fir/pine forests are common at lower elevations with Douglas-fir/true fir forests at higher elevations."

Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) make up the majority of the California Klamath Province, the Western Klamath (KLW) and Eastern Klamath (KLE) regions. The ICC modeling region, which is described above, represents a relatively small southern portion of the California Klamath province. The KLW is described below:

"A long north-south trending system of mountains (particularly South Fork Mountain) creates a rain shadow effect that separates this region from more mesic conditions to the west. This region is characterized by very high climatic and vegetative diversity resulting from steep gradients of elevation, dissected topography, and the influence of marine air (relatively high potential precipitation). These conditions support a highly diverse mix of mesic forest communities such as Pacific Douglas-fir, Douglas-fir tanoak, and mixed evergreen forest interspersed with more xeric forest types. Overall, the distribution of tanoak is a dominant factor distinguishing the Western Klamath Region. Douglas-fir dwarf mistletoe is uncommon and seldom used for nesting platforms by Spotted Owls. The prey base of Spotted Owls within the Western Klamath is diverse, but dominated by woodrats and flying squirrels. This region

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890 contains the Willow Creek, Hoopa, and the western half of the Oregon Klamath DSAs.” (USFWS
891 2011a, pg C-12)

892 The KLE differs from K LW by the reduced influence of marine air and a slightly varying forest
893 composition. The KLE is described below:

894 “This region is characterized by a Mediterranean climate, greatly reduced influence of marine
895 air, and steep, dissected terrain. Franklin and Dyrness ([1973]) differentiate the mixed conifer
896 forest occurring on the “Cascade side of the Klamath from the more mesic mixed evergreen
897 forests on the western portion (Siskiyou Mountains), and Kuchler (1977) separates out the
898 eastern Klamath based on increased occurrence of ponderosa pine. The mixed
899 conifer/evergreen hardwood forest types typical of the Klamath region extend into the southern
900 Cascades in the vicinity of Roseburg and the North Umpqua River, where they grade into the
901 western hemlock forest typical of the Cascades. High summer temperatures and a mosaic of
902 open forest conditions and Oregon white oak woodlands act to influence Spotted Owl
903 distribution in this region. Spotted Owls occur at elevations up to 1768 m. Dwarf mistletoe
904 provides an important component of nesting habitat, enabling Spotted Owls to nest within
905 stands of relatively younger, small trees. The western half of the South Cascades DSA and the
906 eastern half of the Klamath DSA are located within this modeling region.” (USFWS 2011a, pg C-
907 12)

908 As mentioned above, Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) provides an important
909 component of nesting habitat, enabling Northern Spotted Owls to nest within stands of relatively
910 younger small trees (USFWS 2011a). Its distribution coincides with the distribution of Douglas-fir from
911 southern British Columbia to central Mexico (Hadfield et al. 2000).

912 The propensity for Northern Spotted Owls to utilize old structurally complex forests in the California
913 Klamath Province for nesting and roosting is supported by numerous studies on public and private
914 timberlands. Table 3 provides a detailed summary of habitat studies in the Klamath Province. Foraging
915 habitat may contain the typical older forest components of nesting and roosting habitat, but may also
916 include younger forests, hardwood stands, and more open areas (Solis and Gutiérrez 1990, Zabel et al.
917 1995, Irwin et al. 2012, Irwin et al. 2013).

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919 **Table 3.** Description of suitable habitat from studies of Northern Spotted Owl habitat relationships in the Klamath
920 Province (partially adapted from USFWS 2009, Table III.C.1).

Study	Location	Method	Description of Selected or Suitable Habitat
USFWS 1992, Bart 1995	Washington, Oregon, northern California	research synthesis (various methods)	conifer-dominated forest with a multi-layered canopy, average DBH1 >30 inches, >60% canopy cover, decadence (snags, logs, deformed trees)
Anthony and Wagner 1999	southwestern Oregon	aerial photographs, ground reconnaissance	conifer-dominated forest with a multi layered canopy, >40% canopy cover, decadence, large snags and logs; characterized by trees >30 inches DBH and >200 yrs
Blakesley et al. 1992	northwestern California	ground sampling, USFS timber stratum maps	coniferous forest characterized by trees >53.3 cm in diameter, forests at 300-900 m elevations for roosting, and the lower third of slopes within a specific drainage
Carey et al. 1992	southwestern Oregon	aerial photographs, forest inventory data, ground reconnaissance	multi-layered canopy, average DBH of dominant trees >39.4 inches, large snags and logs
Dugger et al. 2005	southwestern Oregon	aerial photographs, ground reconnaissance	conifer or mixed forest, >100 yrs; characterized by trees >13.8 inches DBH
Franklin et al. 2000	northwestern California	satellite imagery	forest comprised of >40% conifers, conifer QMD2 >21 inches, hardwood QMD >6 inches, canopy cover >70%
Gutiérrez et al. 1998	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Hunter et al. 1995	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Irwin et al. 2012	southwestern Oregon and northcentral California	ground sampling, modeling	Selection tied to increasing average diameter of coniferous trees and also with increasing basal area of Douglas-fir trees, increased with increasing basal areas of sugar pine hardwood trees and with increasing density of understory shrubs. Large-diameter trees (>66 cm) appeared important <400 m from nest sites.
Irwin et al. 2013	southwestern Oregon and northcentral California	forest inventory from private and federal landowners, modeling	Basal area (m ² /ha) between 35-60 in nesting period, and 30-54 in winter period, basal area of trees >66 cm was between 7-22 in nesting period, and 7-18 in winter period, QMD 37-60 in nesting period and 37-61 in winter period.
LaHaye and Gutiérrez1999	northwestern California	ground sampling	83% of nests located in Douglas-fir, 60% of nests located in brokentop trees, nest within forests characterized by large (> 90 cm dbh) conifers, a hardwood understory, and a variety of tree

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			sizes.
Meyer et al. 1998	western Oregon	aerial photographs	conifer-dominated forest, trees >80 yrs and/or multi-layered canopy
Ripple et al. 1997	southwestern Oregon	aerial photographs	conifer-dominated forest, average DBH >19.7 inches, canopy cover >60%
Solis and Gutiérrez 1990	northwestern California	timber type classification	average DBH >20.7 inches
Zabel et al. 1993	northwestern California	topographic maps, aerial photographs, and orthophotoquads	stands dominated (in terms of basal area) by trees >20.9 inches DBH; >20% canopy cover of dominant trees and >70% canopy cover of trees >5.1 inches DBH
Zabel et al. 2003	northwestern California	modified timber type classification, varied geographically	<u>nesting-roosting habitat</u> : for most locations average DBH >17 inches and average conifer canopy cover >60%; <u>foraging habitat</u> : in all locations average DBH >9.8 inches and average conifer canopy cover >40%, additional criteria in some locations

921

922 California Cascade Province

923 A description of the California Cascades province is noted below, as defined in the 1992 Northern
924 Spotted Owl recovery plan (USFWS 1992):

925 “The California Cascades province is bordered by the Oregon Cascades province, the Oregon and
926 California Klamath provinces, and the north end of the Sierra Nevada. It is the link between the
927 range of the northern Spotted Owl and the range of the California Spotted Owl. Suitable owl
928 habitat, which is fragmented on a broad scale by high- and low-elevation areas containing
929 marginal habitat, is predominately in two national forests. However, there are significant blocks
930 and checkerboard ownership areas where industrial private lands can provide suitable habitat.”

931 One modeling region described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) makes
932 up the majority of the California Cascades province, Eastern Cascade - South (ECS). The ICC modeling
933 region, which is described above, represents a relatively small southern portion of the California
934 Cascades province. The ECS is described below:

935 “Topography is gentler and less dissected than the glaciated northern section of the eastern
936 Cascades. A large expanse of recent volcanic soils (pumice region: Franklin and Dyrness [1973]),
937 large areas of lodgepole pine, and increasing presence of red fir and white fir (and decreasing
938 grand fir) along a south-trending gradient further supported separation of this region from the
939 northern portion of the eastern Cascades. This region is characterized by a continental climate
940 (cold, snowy winters and dry summers) and a high-frequency/low-mixed severity fire regime.
941 Ponderosa pine is a dominant forest type at mid-to lower elevations, with a narrow band of

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942 Douglas fir and white fir at middle elevations providing the majority of Spotted Owl habitat.
943 Dwarf mistletoe provides an important component of nesting habitat, enabling Spotted Owls to
944 nest within stands of relatively younger, smaller trees.” (USFWS 2011a, pg C-11, C-12)

945 Compared to other provinces in California, very little is known about the specific needs of the Northern
946 Spotted Owl in the California Cascades. In addition, no studies have been conducted to date evaluating
947 habitat quality (the amount and type of habitat most beneficial to owls) across owl sites in the California
948 Cascade Province. Recent telemetry work on foraging habitat use and selection has been conducted on
949 three large study areas at the interface of the southern Cascades and eastern Klamath Mountains in
950 southern Oregon and north-central California (Irwin et al. 2012, 2013). These studies provide valuable
951 information on foraging habitat use in the California Cascade region, but without demographic
952 performance information the results have limited utility for identifying the habitat’s quality for owls.

953 Irwin et al. (2012 and 2013) found that Northern Spotted Owls in Oregon and northwestern California
954 selected areas with greater density and basal area of trees >66 cm dbh (>26 dbh) within 400 m (0.25 mi)
955 of nest sites. The authors suggest a plausible optimal landscape for Spotted Owls in the region might
956 include stands of large-diameter trees near nest sites which are embedded in a heterogeneous forest
957 landscape of various selected foraging types. Modeling owl habitat based upon characteristics used
958 during nighttime foraging excursions, Irwin et al. (2012) found that owls selected mixed-aged and mixed
959 coniferous forest stands. In this study, the Yreka study site was inclusive of dry forest types on the
960 California Cascade Province.

961 In a modeling effort within the Klamath and Cascade provinces, habitat parameters were compared
962 among all forest types within the owls range in California, Oregon and Washington (considered habitat
963 across the entire range at the time) with that of California-specific knowledge of owl habitat within
964 Klamath and Cascade provinces (Zabel et al. 2003). These revised parameters considered new nesting,
965 roosting and foraging habitat types and attributes (e.g., younger trees, elevation, aspect, California-
966 specific soil classes) that the range-wide habitat map left out. The revised model performed better at
967 predicting owl occupancy in California’s interior forest types than the range-wide model. The study
968 concluded that modeling California habitat independent of range-wide habitat was more effective at
969 predicting owl occupancy and numbers in California interior forest types.

970 *Habitat Effects on Survival and Reproduction*

971 Habitat quality has been evaluated in a number of ways including: assessing density of owls in different
972 habitat types, comparing vital rates between owl sites with different habitat conditions, modeling vital
973 rates for populations of owls across broad areas that exhibit differences in landscape scale forest
974 composition, and modeling vital rates at individual owl territories with specific forest structure and
975 composition. The type, extent, and spatial configuration of forests in a high quality territory vary across
976 the range of the Northern Spotted Owl and across regions of California. Although many different
977 combinations of habitat can support a productive Northern Spotted Owl pair with high fitness, the body
978 of evidence suggests minimum thresholds for amounts and distributions of various forest types within
979 any given Northern Spotted Owl home range.

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980 In the recent broad demographic analysis (Forsman et al. 2011), habitat variables were evaluated for
981 effect on fecundity, survival, and rate of population change. Habitat data were not available for
982 California, and so effect of habitat on demographic rates could only be evaluated for Oregon and
983 Washington. In all Oregon study areas, modeling revealed strong evidence for an effect of suitable
984 habitat on fecundity. Four of five Oregon study areas showed declines in fecundity with decreases in
985 suitable habitat, however, the Klamath study area of southwest Oregon showed the opposite
986 relationship, with fecundity declining with increases in suitable habitat. The latter result is consistent
987 with one territory-based analyses in the Klamath province in California which showed an increase in
988 fecundity with decreases in mature forest (Franklin et al. 2000), but is inconsistent with a territory-based
989 analysis in the Klamath province of southern Oregon (Dugger et al. 2005). An additional study in
990 southern Oregon, although not in the Klamath Province, also showed an increase in fecundity with
991 decreases in mature forest (Olson et al. 2004).

Comment [EMG9]: Will need to be updated with info from Dugger et al. 2015. CA data are included in this latest paper.

992 There was weak evidence for a relationship between the percent cover of suitable habitat and apparent
993 survival for four study areas in Oregon and Washington (Forsman et al. 2011). This is in contrast to three
994 territory-based analyses in California and southern Oregon which found positive relationships between
995 survival and mature forest (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). It is likely that
996 habitat influences demographic rates of individual spotted owls on a home range or territory scale.
997 Therefore where finer-scale data have been available, studies conducted at the scale of owl territories
998 are more likely to detect an effect and are likely more representative of individual Spotted Owl habitat
999 requirements than the broad meta-analysis.

1000 Territory-based studies have revealed that owls occupy sites that vary in quality, with pairs exhibiting
1001 various levels of survival and productivity in association with habitat type. For example, Bart and
1002 Forsman (1992) found that Northern Spotted Owl productivity increased with increasing amount of
1003 older forests. Similarly, using turnover rates to define survival Bart and Ernst (1992) found that adults
1004 remained in a territory longer when mature and old-growth was present within the territory.

1005 Certain habitat characteristics have been shown to support high quality Northern Spotted Owl
1006 territories, with both the amount and spatial configuration of different habitat types at a territory
1007 contributing to levels of survival and productivity in the resident owls. This measure of habitat quality at
1008 the scale of Northern Spotted Owl home range has been termed "habitat fitness potential" (HFP). HFP
1009 was defined by Franklin et al. (2000) as "...the fitness conferred on an individual occupying a territory of
1010 certain habitat characteristics." and is determined by modeled values of lambda (λ ; defined as annual
1011 rate of population change²) and the rates of survival and reproduction that influence λ (Franklin et al.
1012 2000, Olson et al. 2004, Dugger et al. 2005). The habitat characteristics that influence HFP include the
1013 amount of nesting, roosting, and foraging habitat, as well as the amount of non-habitat. The spatial
1014 configuration of these different habitat types around an activity center has also been shown to be

² See section on Demographic Rates below for a discussion of lambda and fitness.

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important in determining HFP. Studies that have evaluated HFP vary somewhat in the size of core areas evaluated and some have evaluated a broader area representing the broader home range. Studies have occurred in southwestern Oregon and northwestern California and so represent different geographic areas and forest types, although most are largely in the Klamath Province of Oregon and California. Three territory-based studies at study areas in the interior of California and southern Oregon have found fairly strong associations between habitat characteristics and demographic rates of northern spotted owls (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). These studies are summarized below and in Table 4.

Each of the three studies attempted to evaluate the effect that older forests (representing nesting/roosting habitat) and other habitat components have on owl demographic rates. In all cases the authors have attempted to capture habitat composed of the oldest forests in the study area to represent high quality nesting and roosting habitat, based on the strong association of the Northern Spotted Owl with mature and old-growth forests. Availability of data for each study area resulted in different definitions of nesting and roosting habitat in each study. Depending on the study, additional attributes evaluated included nonhabitat (e.g., nonforested areas) and amount of edge between various land cover types.

Franklin et al. (2000) modeled the relationship between owl habitat covariates in the core area of Spotted Owl home ranges and Northern Spotted Owl fitness in portions of the north Coast Range and the Klamath Mountains in California. In this study, Northern Spotted Owl habitat was defined as “mature and old-growth forest with a quadratic mean diameter of ≥ 53 cm, quadratic mean diameter of hardwoods ≥ 15 cm, percentage of conifers $\geq 40\%$, and overstory canopy coverage of $\geq 70\%$.” Apparent survival increased with an increased amount of owl habitat, with the amount of edge between owl habitat and other habitat, and at intermediate distances between patches and owl habitat. There was a rapid decrease in survival when the amount of owl habitat fell below about 100 acres (40 hectares) of owl habitat within the core use area. Reproductive rate also increased with an increase of edge between owl habitat and other habitat types, but decreased with increasing amount of owl habitat. Reproductive output had a non-linear relationship with amount of owl habitat, only increasing substantially when the amount of owl habitat was less than 75 to 100 acres (30 to 40 hectares). Variation in survival was attributed mostly to habitat, whereas variation in reproductive output was attributed to both to habitat and climatic events (e.g., cold heavy rains during peak breeding season). HFP was maximized in sites with sufficient owl habitat to facilitate high survival and sufficient edge to facilitate both high survival and high reproductive output. Given this, the authors suggest that there is a trade-off between the amount of owl habitat and edge required to maximize survival and reproduction, while at the same time noting that the components of quality edge habitat are still poorly understood since the study did not discriminate between types or amount of “other habitat”. Despite the trade-off between survival and reproduction, estimates of λ have been shown to be driven by survival rates in Northern Spotted Owls (Forsman et al. 2011), and “...low amounts of spotted owl habitat within a territory will not supply the high degree of edge predicted to support high reproductive output” (Franklin et al. 2000).

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1054 **Table 4.** Comparison of three territory-based demographic studies in the interior of California and southern
1055 Oregon.

	Franklin et al. 2000	Olson et al. 2004	Dugger et al. 2005
Definition of older forest evaluated in the study (representing nesting/roosting habitat)	Spotted owl habitat = mature and old-growth forest with QMD of conifers >53 cm (~21 in), QMD of hardwoods >15 cm (~6 in), percentage of conifers >40%, and overstory canopy coverage >70%	<u>Late-seral forest</u> = stands characterized by trees with >80 cm (~31.5 in) dbh; generally associated with high quality nesting, roosting, and foraging habitat. <u>Mid-seral forest</u> = stands characterized by trees with 24-80 cm (9.5 - 31.5 in) dbh.	<u>Old forest</u> = older (>100 years) conifer or mixed stands characterized by canopy cover >40% and trees >35cm (~14 in) dbh. <u>Old growth</u> = old (>200 years) conifer-dominated stands characterized by canopy cover >40% and trees >75 cm (~29.5 in) dbh.
Relationship between older forest and <u>survival</u>	Positive Survival declined rapidly at sites with less than ~100 acres of spotted owl habitat in the core area (i.e. <25%) Core area = 390 acres	Positive In general, late-seral forest had a positive effect on survival. However, the best model showed highest survival when combined mid- and late-seral forest was about 70% of the 1,747 acre (1,500-m radius) circle	Positive Pseudothreshold relationship with survival rate dropping rapidly when proportion of old forest in the core drops below ~20-30% (~80-100 acres) Core area = ~413 acres
Relationship between older forest and <u>productivity</u>	Negative Nonlinear relationship with reproductive output increasing when amount of older forest in the core area is less than ~75-100 acres	Negative Productivity declined with increases in mid- and late-seral forest	Positive Linear effect with old growth forest in the core area providing the best model
Amount of older forest in the core area for high fitness territories^a	Variable, with an apparent trade-off between providing sufficient older forest to support survival and provide a high amount of edge, while limiting portion of core area in older forest in order to support high productivity (see Fig 10 in Franklin et al.; generally at least ~25% older forest required in core to support high fitness)	N/A The best model included only the 1,500m diameter circle (~1,747 acres representing broader home range)	In general, territories with <40% of the 413 acre core (~165 acres) composed of older forests had habitat fitness potential <1.0
Effect of habitat in broader home range or 'outer ring' on vital rates^b	N/A	Territories with high estimates for λ had a high amount of mid- and late-seral forest in the 1,747 acre area, but also have patches of nonforest within the mosaic of forest types	Survival declined when the amount of nonhabitat in the outer ring portion of the home range exceeded about 60%.
Relationship of vital rates with the amount of non-habitat (non-forest areas, sapling stands, etc.)	Did not evaluate ^c	Increases in early seral and nonforest had a negative effect on survival	Survival decreased dramatically when the amount of non-habitat exceeded ~50% of the home range

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Relationship of vital rates with amount of edge between older forest and other vegetation types ^d	Both apparent survival and reproductive output increased with increasing edge between spotted owl habitat and other vegetation types ^e	The best model showed a positive relationship between productivity and amount of edge between mid- and late-seral forest and the other types (early-seral and nonforest).	No support for either a positive or negative effect on survival or reproductive rate
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^aSize of the core area evaluated varies across studies. Franklin et al. (2000) evaluated a 390 acre core area. Olson et al. (2004) evaluated a ~279 acre core area, but their best model included only the 1,500m diameter circle (~1,747 acres). Dugger et al. (2005) evaluated a ~413 acre core area.

^bSize of the broader home range or 'outer ring' evaluated varies across studies. Franklin et al. (2000) did not include an outer ring of habitat or broader home range in their modeling. Dugger et al. (2005) evaluated a ~3,455 acre outer ring. In addition to the core area, Olson et al. (2004) evaluated two larger circles of habitat of ~1,747 and ~4,473 acres.

^cFranklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types.

^dEdge is defined differently among the studies. Franklin et al. (2000) defined edge as occurring between mature forest (spotted owl habitat) and all other vegetation types. Olson et al. (2004) and Dugger et al. (2005) define edge as occurring between nonhabitat and all intermediate and mature forest types.

^eFranklin et al. (2000) were unable to distinguish different types of edge, but suggested that edges between spotted owl habitat and clearcuts do not generate the type of mosaic that was observed in high-fitness territories.

In their Oregon coast study area, Olson et al. (2004) analyzed various forest types: late-seral, mid-seral (broken further into conifer and broadleaf), and non-forest, within 600, 1,500 and 2,400 m radius around Northern Spotted Owl site centers. The best model indicated survival was highest when the amount of mid- and late-seral forest was about 70% within the 1,500 m (0.9 mi) radius circle, and survival decreased when the amount of mid- and late-seral forest increased above about 85% or declined below about 50%. Increases in early seral or non-forest had a negative effect on survival. The best model indicated reproductive rates were positively correlated to the amount of edge between mid-seral and late-seral forest and other forest types (early-seral or non-forest), and suggested a high amount of mid- and late-seral forest in the 1,747 acre area with patches of nonforest within the mosaic of forest types provided high fitness.

In an Oregon study (including portions of the western Cascades and eastern Siskiyou Mountains, both comparable to areas in California), Dugger et al. (2005) found the best models contained a positive linear effect of older forest types in the core area (defined as 413 acres) on reproductive rate, with the best model including old-growth. There was strong evidence to support a positive relationship between amount of older forest types in the core area, and an increase in apparent survival. Dugger et al. (2005) found little to no effect on survival and reproduction rate for intermediate-aged forests, defined as forests between sapling and mature stages with total canopy cover over 40%. The study also analyzed habitat within a broader area around the core area, representing an outer ring of the home range (3,455 acres outside of the core area). Within the broader area, survival declined when the amount of non-habitat, defined as non-forest and early seral stages including sapling stage, within the ring outside the core area exceeded 60%. Survival estimates were highest when the amount of non-habitat fell between roughly 20 to 60% in the broader portion of the home range, and survival estimates were lower as non-habitat fell below 20% or above 60%. Modeling efforts did not find any direct effect of edge, although edge was defined differently than in the Franklin et al. (2000) study. Although Dugger et al. (2005) did

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1093 not find any evidence that a mosaic of old forest intermixed with forests of intermediate age (with
1094 hardwood component) provided benefit to the Northern Spotted Owl, nor a benefit of edge, the
1095 negative quadratic relationship between owl survival and amount of non-habitat in the broader portion
1096 of the home range may suggest some benefit of an intermediate amount of “edge” in this larger area.
1097 The study concludes, “in general, territories with <40% old forest or old-growth habitat near the site
1098 center had habitat fitness potential <1, consistent with the relationships between both reproduction
1099 and survival and the amount of old forest habitat at the core.”

1100 All three of the above studies found a positive relationship between the amount of late-seral forest and
1101 survival, with two (Franklin et al. 2000, Dugger et al. 2005) showing a rapid decline in survival when the
1102 amount of late-seral forest in the core area dropped below about 25% (i.e., about 100 acres of late-seral
1103 forest is required in the 400 acre core to support survival). The third study (Olson et al. 2004) found that
1104 declines in survival accelerated when the amount of mid- and late-seral forest in a larger area (~1,750
1105 acre) declined below 50%, with highest survival at 70% mid- and late-seral forest. Two of the three
1106 studies found a negative relationship between the amount of older forest and productivity in the core
1107 area (Franklin et al. 2000) or in the broader home range (Olson et al. 2004); this shows an apparent
1108 trade-off between providing sufficient older forest to support survival, while limiting the amount of
1109 older forest in order to support high productivity. The third study found a positive relationship between
1110 older forest in the core area and productivity (Dugger et al. 2005).

1111 Dugger et al. (2005) found that territories required that about 40% of the core area be composed of
1112 older forests in order for HFP to be greater than 1.0. The results of Franklin et al. (2000) suggest that
1113 about 25% of the core area must be in older forest to support high fitness. The two studies that
1114 evaluated a broader home range found that the amount of non-forested area and other forms of
1115 nonhabitat must be limited in order to support high HFP (Olson et al. 2004, Dugger et al. 2005). Olson et
1116 al. (2004) and Dugger et al. (2005) both found that survival decreased dramatically when the amount of
1117 early seral forest or other non-habitat exceeded ~50% of the home range.

1118 In their coastal study area within California’s Humboldt and Del Norte counties, Thome et al. (1999)
1119 showed that reproductive rate was inversely related to age class and basal area age classes within
1120 forests managed with clear-cut silviculture practices. Specifically, sites with high proportions of 21-40
1121 year-old stands, lower proportions of 61-80 year-old stands and the largest basal area class (>69 m²/ha)
1122 had higher reproduction; however sites with higher reproduction also had more residual trees at 50
1123 hectare circle (0.149 trees/ha) and 114 hectare circle (0.201 trees/ha) surrounding owl sites. The
1124 explanation was presumed to be related to the larger abundance of preferred prey (i.e., woodrats)
1125 among younger forests coupled with the limited availability of older forests on the study area. The
1126 authors concluded that 21-40 year-old stands were young enough to contain sufficient amounts of prey
1127 during foraging, yet old enough to provide structural for roosting, nesting, and maneuverability, such as
1128 high canopy and large residual trees.

1129 It is important to note that the relationships found between owl fitness and habitat in the studies
1130 described above apply only to areas with similar conditions as those analyzed as part of the studies, and
1131 findings may not be applicable to owl territories throughout the owl’s entire range in California. For

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example, the study area described in Olson et al. (2005) comprised different forest types than those described in Dugger et al. (2005) or Franklin et al. (2000) and where the primary food source was flying squirrels rather than woodrats.

Overall, Northern Spotted Owls require some minimum level of old forest, including old-growth, within their core range and broader range to optimize survival and productivity. It is also apparent that older forest mixed with other forest types (excluding non-habitat) benefits Northern Spotted Owl fitness, at least partially due to the increased foraging opportunities along transitional edges. This effect may be more prevalent in the interior zones of California and southern Oregon, (Klamath and Cascade provinces) where owl habitat differs significantly than coastal or more northern portions of the range. In spite of uncertainties around which level of old forest and edge attains the best fitness for owls, the literature points to the benefits of a mosaic of forest types that contain sufficient older forest, especially around the core area, while limiting the amount of nonhabitat in the home range. Based on the studies in the interior of the species' range in California and southern Oregon, management that maximizes late-seral forest in the core area (at least 25-40%) while limiting the amount of nonforest or sapling cover types throughout the home range (no more than about 50%) would likely result in high quality Spotted Owl territories.

Comment [A10]: Note to external reviewers:
Prior to final draft, we will consider adding Figure 6 from Dugger et al. (2005) or Figure 10 from Franklin et al. (2000) to illustrate the amounts and configuration of various habitat types in high quality territories.

Comment [EMG11]: Good summary paragraph!

Status and Trends in California

Abundance

No range-wide estimate for abundance of Northern Spotted Owl exists because survey methods and effort conducted to date do not provide for reliable estimation of population size across the range (USFWS 2011a). Few areas across the range have been sufficiently sampled to accurately estimate densities of Northern Spotted Owls (Franklin et al. 1990, Tanner and Gutiérrez 1995, Diller and Thome 1999). As mentioned above, Northern Spotted Owl densities vary across the range and forest types and so extrapolating the few local estimates across the range of the subspecies would result in biased estimates of abundance (See Life History section of this report for detailed information in density estimates in California). Because Northern Spotted Owls have large home ranges it is necessary to systematically survey very large areas in order to obtain reliable estimates of density (Franklin et al. 1990). Diller and Thome (1999) suggested that unless most individuals in a population are marked, density estimates would be biased. Studies that have provided density estimates have applied only to territorial owls (Diller and Thome 1999). Surveys do not effectively sample nonterritorial individuals (floaters); therefore, little is known about the floater population of owls other than they exist and that they generally do not respond to broadcast surveys. This leads to an issue of detectability that is difficult to overcome in estimating density or abundance of Northern Spotted Owls in a given area. Without an effective sampling method that addresses the ability to detect all owls in a given area, it is not possible to provide an accurate estimate of abundance. See the discussion on occupancy in the Demographic Rates section of this report for potential effects of floater owls on occupancy rates at known owl sites.

Comment [EMG12]: I think this section could be shortened considerable since abundance is not nor has it ever been a metric that is used to track spotted owl population status.

Comment [EMG13]: Non territorial floaters are a small proportion of the total owl population. Surveys are highly effective for sampling resident, territorial owls and estimating occupancy. The design of most surveys is such that detection probability can be estimated from the survey data. While you are correct that we cannot get accurate estimates of total abundance, survey data are extremely effective for population monitoring (e.g. occupancy, rate of population change, survival, etc.). I would end this paragraph with a statement saying something to the effect that density and abundance are difficult to estimate for this species, however, survey data provides highly useful data on other demographic rates that can be used to track population status.

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An early report out of the California Forestry Association (Taylor 1993) attempted to derive a population estimate for the Klamath Province in California. However, many assumptions were required in the analysis process, especially in developing estimates for amount of suitable habitat on federal and private land, estimating the fraction of land that had previously been surveyed, and estimating the proportion of sites that are occupied. In addition, no criteria were mentioned for what constituted “suitable” habitat, although 100% of forested land not owned by the USFS was considered to be suitable. The paper acknowledges that several of the assumptions made in deriving the population estimate are untested and that high levels of uncertainty exist in many of the estimates. Taylor (1993) partitioned land into ownership type, estimated the amount of suitable habitat on each type, estimated the fraction of land surveyed on each type, used the number of activity centers in the Department database and the estimates for fraction of suitable habitat surveyed to obtain an estimate of total sites in each type, and used an average occupancy rate from a subset of sites to extrapolate occupancy across the entire province. Estimates for suitable habitat and the percentages of suitable land surveyed for owls were derived from telephone interviews with landowners, timber company GIS layers and Timber Harvest Plan (THP) data, and a U.S. Forest Service report for National Forests. Due to the many untested assumptions and high amount of uncertainty in estimates, and the vague description of methods used, the report cannot be considered to provide a valid population estimate for the Klamath Province.

A recent study made use of the immense amount of data available on Northern Spotted Owl habitat requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity, dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the range of the owl (Schumaker et al. 2014). In addition to an evaluation of source-sink dynamics, outcomes of the model included a range-wide population size estimate, and the proportion of the population in each modeling region and physiographic province noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). Estimates of regional population sizes indicate that Northern Spotted Owls are most abundant in parts of southern Oregon and northern California (Table 5). The three California provinces were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population. The model indicated that the Klamath region is a stronghold for the population, with 50.1 percent cumulatively within the Oregon Klamath and California Klamath provinces, and 37.1 percent within the Klamath East and Klamath West modeling regions. Schumaker et al. (2014) estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions. Although informed by the best available data to develop an impressive assessment of source-sink dynamics across the range, the complexity of the model may limit its ability to accurately model population estimates. For example, differences in the simulated number of owls versus the numbers observed in eight demographic study areas used for calibration ranged from 5 to 47 percent (Schumaker et al. 2014). Nevertheless, the results suggest that California’s population of Northern Spotted Owls is an important component of the range-wide population.

Comment [EMG14]: The goal of this paper was not to come up with an estimate of abundance, but rather to use a reasonable estimate for the modeling process.

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Table 5. Percent of range-wide Northern Spotted Owl population within modeling region and physiographic province (adapted from Table 2 in Schumaker et al. 2014).

Modeling Region	Percent of Population	Physiographic Province	Percent of Population
North Coast Olympics	0.1	Washington Western Cascades	1.3
West Cascades North	0.1	Washington Eastern Cascades	1.6
East Cascades North	3.3	Washington Olympic Peninsula	>0.0
West Cascades Central	1.2	Washington Western Lowland	>0.0
Oregon Coast	1.0	Oregon Eastern Cascades	3.5
West Cascades South	15.3	Oregon Western Cascades	23.3
Klamath West	20.0	Oregon Coast	0.8
Klamath East	17.1	Oregon Willamette Valley	>0.0
Redwood Coast	16.4	Oregon Klamath	13.7
East Cascade South	3.8	California Coast	16.6
Inner California Coast	21.7	California Cascades	2.8
		California Klamath	36.4

Most surveys for Northern Spotted Owls have been conducted on areas proposed for timber management activities in order to assess the potential for impacting the species, or on demographic study areas throughout the subspecies range. Although not designed for estimating density or abundance, pre-harvest surveys have dramatically increased knowledge on location of territorial owl sites (i.e., activity centers). As survey effort has expanded to new areas over time, the number of known activity centers has naturally increased. Although owls will shift activity centers over time, they exhibit high site fidelity to general nesting and roosting areas (Gutiérrez et al. 1995, Blakesley et al. 2006), therefore the increase in number of activity centers over time is more likely a result of expanded survey effort than establishment of new activity centers. In addition, across most of the Northern Spotted Owl range establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a slow process given tree species growth rate, and so a rapid increase in the number of activity centers due to colonization of new habitat is unlikely. The possible exception to this is on the redwood coast where Northern Spotted Owls have been shown to select relatively young forests (41-60 years old) for nesting and roosting, as long as all habitat requirements are present (Thome et al. 1999). For example, Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature (GDRC 2015). The number of newly established activity centers across the range as a result of newly available nesting and roosting habitat is unknown. See the discussion on habitat changes in the threats section for additional information on the topic of habitat recruitment. The Humboldt Redwood Company has also reported an increase in number of sites since 2008 (HRC 2015). A concurrent increase in detections of Barred Owls in heavily surveyed areas suggests that the increase in Spotted Owl activity centers is likely due at least in part to increased survey effort (see Figure 28 in the Threats section of this report). However, it is possible that the increase in Spotted Owl activity centers is due to the movement of Spotted Owls as a result of displacement by an increasing number of Barred Owls (HRC 2015) or displacement from lands that are no longer suitable due to timber harvest or wildfire.

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In California, the number of known Northern Spotted Owl activity centers rapidly increased starting around 1990 when listing under the federal Endangered Species Act resulted in a widespread increase in survey effort (Figure 3). Through 1989, there were 1,366 Northern Spotted Owl activity centers in California. By the year 1999, this number had increased to 2,799. As of 2014, the number of Northern Spotted Owl activity centers was 3,116. The number of occupied activity centers in any given year is unknown because not all areas have been or can be surveyed on an annual basis (USFWS 2011a). It is likely that many of the known sites are unoccupied because of habitat loss due to timber harvest or severe fires, displacement by Barred Owls, or other factors, therefore much of the data from early survey reports are outdated and of little use in addressing population abundance or distribution questions (Courtney et al. 2004). For these reasons and for the sampling reasons discussed above, the number of activity centers does not represent an index of abundance but rather the cumulative number of territories recorded (USFWS 2011a).

Demographic Rates

“Because the existing survey coverage and effort are insufficient to produce reliable range-wide estimates of population size, demographic data are used to evaluate trends in Spotted Owl populations” – USFWS (2011a).

The U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) initiated eight long-term demography studies within the range of the Northern Spotted Owl during the years 1985 to 1991 in order to provide data on the status and trends of Spotted Owl populations, and to inform the effectiveness of the NWFP on federal lands (Lint et al. 1999). Additional demographic study areas that were not established under the NWFP have also been initiated. The additional study areas that are currently active include one entirely on private land (i.e., Green Diamond Resource Company), one on the Hoopa Indian Reservation land, and one composed of a mix of federal, private, and state lands (i.e., Rainer). The study areas range between Washington and northern California, and collectively represent about 9% of the range of the Northern Spotted Owl (Forsman et al. 2011; Figure 7).

These eleven study areas have been monitored annually since inception with an average of 19 survey years across all areas (Table 6). On each study area, territorial owls are captured and banded, followed by annual attempts to recapture or resight owls and to evaluate reproductive success of territorial pairs. Standard protocols ensure consistent and thorough attempts to band and resight territorial owls and to assess nesting status of territorial females (Anthony et al. 2006). Over the period of 17-24 years (depending on study area), a total of 5,224 non-juvenile owls have been marked in the eleven study areas with a total of 24,408 annual captures/recaptures/resightings, allowing for robust estimates of survival. The number of young produced by territorial females was determined in 11,450 separate cases (Forsman et al. 2011). Three study areas are located in California, representing a diverse land ownership; the Northwest California study area (NWC) is primarily on federal land, the Green Diamond Resource Company study area (GDR) is on private land, and the Hoopa Indian Reservation study area (HUP) is on tribal land. These three study areas cover approximately 6% of the range of the Northern Spotted Owl in California (based on the USFWS range). The GDR study area is entirely within the California Coast Province, the HUP study area is located on the western edge of the California Klamath Province, and the

Comment [EMG15]: Survey data reflect occupancy, not abundance. This is a very long explanation of why survey data do not translate to abundance. I think it would be more effective to start this section by simply stating the reasons why we do not use abundance or density estimates for assessing spotted owl population status.

Comment [EMG16]: Yes! This is why the previous section is not particularly relevant.

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NWC study area is mostly in the Klamath Province with a small portion in the Coast Province. There is no demographic study area in the California Cascades Province.

Table 6. Descriptions of 11 demographic study areas used to assess vital rates and population trends through 2008. Adapted from Table 1 and Appendix A in Forsman et al. (2011).

Study Area	Acronym	Years	Area (km ²)	Ownership
<i>Washington</i>				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
<i>Oregon</i>				
Coast Ranges*	COA	1990-2008	3,922	Mixed
H.J. Andrews*	HJA	1988-2008	1,604	Federal
Tyee*	TYE	1990-2008	1,026	Mixed
Klamath*	KLA	1990-2008	1,422	Mixed
South Cascades*	CAS	1991-2008	3,377	Federal
<i>California</i>				
NW California*	NWC	1985-2008	460	Federal
Hoopa Tribe	HUP	1992-2008	356	Tribal
Green Diamond	GDR	1990-2008	1,465	Private

*Indicates the eight study areas that are part of the federal monitoring program for the northern spotted owl.

Data from the demographic study areas have been compiled and analyzed regularly, with the most recent analysis covering all survey years through 2008 (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011). Demographic rates are estimated for each study area, and for all study areas combined (meta-analysis). An additional meta-analysis of data from the demographic study areas is ongoing and will include data through 2013. This additional information should provide further insight into important demographic rates across the species range. As discussed above, data collected from existing surveys are not sufficient to estimate population sizes, and so population trends cannot be assessed by comparing estimates of population size over time. However, the consistent collection of large amounts of capture/recapture data and observations of reproductive effort has resulted in an enormous amount of information which allows for estimation of vital rates across much of the range of the Northern Spotted Owl. When sufficient data is available, examination of demographic trends in survival and reproduction is one of the most reliable methods of assessing the health of a population. These data also allow for estimation of the annual rate of population change, lambda (λ), which reflects changes in population size resulting from reproduction, mortality, and movement into and out of a study area. Lambda does not provide a numerical estimate of population size, but instead estimates the proportional change in a population over a set period of time.

In addition to the coordinated analysis of data from all demographic study areas that occurs every 5 years, reports are available from individual study areas. Results from these reports are included in the discussion below when they offer more current information on the three California study areas than the most recent coordinated meta-analysis of 2011.

Comment [EMG17]: Will need to update with Dugger et al. 2015/

Comment [A18]: Note to external reviewers: Where more recent data on demographic rates are available, either through annual reports or through presentations that have been publicly available, we include results as appropriate. We will update this report to include full results of the ongoing meta-analysis if the full publication becomes available prior to finalizing this status review.

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1299 *Rate of Population Change*

1300 A primary goal of the large scale monitoring at the demographic study areas and the regular coordinated
1301 analysis of data is to monitor population trends of the Northern Spotted Owl through estimation of
1302 lambda (λ , defined as annual finite rate of population change) (Anthony et al. 2006, Forsman et al.
1303 2011). A λ of 1.0 indicates that a population is stationary, whereas values greater or less than 1.0
1304 indicate increasing or declining populations, respectively. The most recent meta-analysis for all eleven
1305 study areas produced a weighted mean λ of 0.971 (standard error = 0.007, 95% confidence interval =
1306 0.960 to 0.983), corresponding to an average rate of population decline of 2.9% per year from 1985 to
1307 2006 (Forsman et al. 2011). Estimates of λ were below 1.0 for all 11 individual study areas, and ranged
1308 from 0.929 to 0.996 (Table 7). Population declines were most pronounced in Washington and the Coast
1309 Ranges of Oregon. The 95% confidence intervals do not overlap 1.0 for seven of the study areas,
1310 indicating strong evidence for population decline on these seven study areas. Although this study area-
1311 level demographic analysis did not show evidence for declines at KLA and CAS study areas, a territory-
1312 based study conducted in the Klamath Mountains and Cascade Range of southwest Oregon showed
1313 evidence for declining populations by 1996 (Dugger et al. 2005). In California, populations at GDR and
1314 NWC have declined, with estimates of λ of 0.972 for GDR (2.8% decline per year) and 0.983 for NWC
1315 (1.7% decline per year).

1316 In a more recent analysis of the available data, Franklin et al. (2015) reported a λ of 0.976 (1985-2013;
1317 95% CI 0.953-0.998) for the Willow Creek Study Area (part of the NWC study area). This shows an
1318 accelerated rate of decline (2.4% decline per year) compared to that reported by Forsman et al. (2011)
1319 for NWC. As reported in Forsman et al. (2011), the 95% confidence interval for HUP overlapped 1.0, so
1320 the study could not conclude that this population was declining through 2008. However, Higley and
1321 Mendia (2013) reported a λ of 0.977 (1985-2012; SE = 0.01; 95% CI 0.958-0.996) equating to a 2.3%
1322 population decline per year through 2012. This is the first time that the 95% CI for HUP does not include
1323 1.0, providing strong evidence that all three study areas in California now have declining populations of
1324 owls.

1325

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Table 7. Demographic parameters for the Northern Spotted Owl demographic study areas through the year 2008. Adapted from Table 22 in Forsman et al. (2011) and Table A-1 in USFWS (2011).

Study Area	Fecundity	Apparent Survival ¹	Lambda (λ)	Population Change ²
<i>Washington</i>				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
<i>Oregon</i>				
Coast Ranges	Increasing	Declining	0.966	Declining
H.J. Andrews	Increasing	Declining	0.977	Declining
Tyee	Stable	Declining	0.996	Stationary
Klamath	Declining	Stable	0.990	Stationary
South Cascades	Declining	Declining	0.982	Stationary
<i>California</i>				
NW California	Declining	Declining	0.983	Declining
Hoopa	Stable	Declining	0.989	Stationary
Green Diamond	Declining	Declining	0.972	Declining

¹ Apparent survival calculations are based on model average.

² Population trends are based on estimates of realized population change.

Conversion of estimates for λ to estimates of realized population change (i.e., the proportional change in estimated population size relative to population size in the initial year of analysis) revealed dramatic declines in regional population sizes (Forsman et al. 2011). The study areas in the northern portion of the range showed precipitous declines, with populations in the Olympic, Cle Elum, and Rainier study areas in Washington and the Coast Range study area in Oregon estimated to have declined by 40 to 60% during the study period (Forsman et al. 2011). At a rate of decline of 2.9% per year, the total population of Northern Spotted Owls across all study areas would have declined by nearly 50% over the 22 years included in the study. Although the 95% confidence intervals for estimates of realized population change slightly overlapped zero, two study areas in California (NWC and GDR) showed estimated population declines of about 20% during the period of study. Using the revised estimate of λ for NWC through year 2013 (Franklin et al. 2015) would result in a larger estimated population decline for NWC. The other study area in California (HUP), showed a slight decline in population size at the end of the study period in 2008, but the 95% confidence interval broadly overlapped zero. Again, using more recent data such as those reported by Higley and Mendia (2013) would provide stronger evidence for a population decline at HUP.

Although the meta-analysis assessing vital rates on all demographic study areas through 2013 is ongoing, preliminary meetings held to coordinate data compilation and analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; the average rate of population decline per year on the eleven demographic study areas has been 3.8% per year (Dugger et al. in review, Higley and Mendia 2013), compared to a decline of 2.9% per year using data

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through 2008 (Forsman et al. 2011). The ongoing analysis has revealed large changes becoming apparent in Oregon and California, with Northern Spotted Owl populations in California declining by 32-55% over the study period (1985-2013; Dugger et al. in review).

Fecundity and Survival

Fecundity (i.e., number of female young produced per adult female) and survival rates are estimated in order to inform estimates of λ , to determine the degree to which changes in these vital rates effect populations, and to model effect of potential explanatory variables on these important vital rates. The Northern Spotted Owl is a long-lived species, with relatively high adult survival rates, and with high variability in fecundity from year to year. Fecundity estimates varied across study areas and ranged from 0.230 to 0.553 female young produced per adult female (Forsman et al. 2011). Most Spotted Owls do not breed every year, but more normally breed every other year, which contributes to low fecundity in the species. There was evidence for declining fecundity on five areas, three areas were stable, and three areas showed increasing fecundity (Forsman et al. 2011). In California, fecundity showed declines on two areas (NWC and GDR) and was stable on one area (HUP), although HUP exhibited the lowest fecundity rate of all eleven study areas. Adult survival has declined on 10 of 11 study areas, with the Klamath study area in Oregon being the exception. Annual survival rate represents the probability that a bird that was alive in one year will be alive the following year, therefore a mean rate of 1.0 would indicate that all birds survive from one year to the next. Values of mean apparent adult survival for the entire study period range from 0.819 to 0.865, with declines most pronounced in Washington and Oregon. Apparent survival rates in Washington had been less than 80 percent in years leading up to 2008, a rate that is unlikely to allow for sustainable populations (Forsman et al. 2011). Although less severe than in Washington and much of Oregon, all California study areas show declines in survival (Table 7).

For most demographic study areas, changes in λ were driven mainly by changes in survival. This is consistent with the hypothetical expectation from a long-lived species with high variability in fecundity over time, and is also consistent with previous studies showing that annual rates of population change are most influenced by changes in adult survival (Noon and Biles 1990, Lande 1991, Blakesley et al. 2001). This is a concerning finding because survival was shown to be declining on 10 of 11 study areas across the entire range of the subspecies, including all three California study areas. In the previous demographic analysis analyzing data from 1985-2003 (Anthony et al. 2006), declines in adult survival in Oregon had not been observed and only one study area in California showed declines, therefore declines in survival in the southern portion of the range occurred predominantly in the most recent five years for which data were available (2004-2008). The overall assessment from the most recent demographic study (Forsman et al. 2011) is that reproduction and recruitment have not been sufficient to balance losses due to mortality and emigration, so many of the populations on study areas have declined over the two decades included in the study.

When the NWFP was implemented, it was assumed that Northern Spotted Owl populations would continue to decline for up to a few decades, but would gradually increase and eventually stabilize as

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1389 habitat protection and successional processes increased available habitat on reserve lands (USDA and
1390 USDI 1994). To date, five meta-analyses have been conducted on data from Northern Spotted Owl
1391 demographic study areas, with results readily available for three of the analyses. A sixth analysis is
1392 ongoing and will include all survey years through 2013. In the second meta-analysis which summarized
1393 results through 1993 (Burnham et al. 1996), no trend in fecundity was detected and survival was shown
1394 to be declining among adult female owls; λ was less than 1.0 for most study areas. The fourth meta-
1395 analysis which covered data through 2003 (Anthony et al. 2006) found evidence for declining fecundity
1396 at six study areas (although 95% confidence intervals overlapped zero for all six areas), and strong
1397 evidence that survival was declining on four of 14 study areas included in the analysis (two of which no
1398 longer participate in the demographic analysis). Mean λ across all study areas was also less than 1.0 with
1399 an annual rate of population decline estimated to be 3.7%, although only four study areas had 95%
1400 confidence intervals for estimates of λ that did not overlap 1.0 (Anthony et al. 2006). The fifth and most
1401 recent meta-analysis covers data through 2008 (Forsman et al. 2011) and provides strong evidence for a
1402 decline in fecundity on 5 of 11 study areas and strong evidence for declining survival on 10 of 11 study
1403 areas. After two decades of NWFP implementation, it is clear that the declining Northern Spotted Owl
1404 populations have not stabilized, and estimates of demographic rates indicate that across much of the
1405 range, the decline has accelerated. This is evident in the declining populations on seven of the 11 study
1406 areas, only two of which showed strong evidence for decline in the previous analysis.

1407 In California, two of three study areas (NWC and GDR) in the recent analysis were shown to be
1408 experiencing declines in fecundity and all California study areas showed declines in survival (Forsman et
1409 al. 2011). The previous analysis also found evidence of declining fecundity on two California study areas
1410 but found evidence for declining survival on only one (Anthony et al. 2006). Although estimates of λ for
1411 study areas in California are not as low as those in Washington and northern Oregon, negative trends in
1412 vital rates had led to population declines on at least two of three California study areas by 2008 (NWC
1413 and GDR). The decline at the NWC study areas had apparently not begun by 1994 (Franklin et al. 2000).
1414 Although Northern Spotted Owls at the southern portion of the range appear to have been temporally
1415 buffered from population declines, the ongoing and accelerating decline in demographic rates had
1416 effected populations in California by 2008.

1417 Most of the demographic study areas were established to evaluate the effectiveness of the NWFP and
1418 consist of federal lands or a mix of federal and nonfederal lands. Although not randomly chosen,
1419 Forsman et al. (2011) suggests that results from the demographic study areas are representative of
1420 federal lands and areas of mixed federal and private lands throughout the range of the Northern
1421 Spotted Owl because “the study areas were (1) large, covering about 9% of the range of the subspecies;
1422 (2) distributed across a broad geographic region and within most of the geographic provinces occupied
1423 by the owl; and (3) the percent cover of owl habitat was similar between our study areas and the
1424 surrounding landscapes”. The authors expressed less confidence that study areas reflected trends on
1425 non-federal lands because the two study areas consisting mainly of non-federal lands (GDR and HUP)
1426 are near the southern edge of the subspecies’ range and both are actively managed for Spotted Owl
1427 habitat. These two non-federal study areas might not accurately represent other non-federal lands in
1428 California because of the management mentioned above and because they are located in the California

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Coast and western edge of the California Klamath physiographic provinces, and may not accurately represent conditions in other parts of the California range, especially the California Cascades. The authors suggested that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands (Forsman et al. 2011).

Although results from the ongoing meta-analysis for the eleven demographic study areas are not yet available, recent reports from individual study areas in California (NWC, HUP, and GDR) provide information on current estimates for reproductive success and survival. At GDR, reproductive success (number of young fledged per monitored site) showed a negative trend from 1992-2014 (regression slope = -0.014), with a mean of 0.54 during this time period (GDRC 2015). This is a different metric of fecundity than used in the most recent demographic analysis (Forsman et al. 2011; number of female young produced per adult female), but shows a continuing decline in productivity since 2008. On HUP, mean reproductive rate (young fledged per monitored female; also a different measure of fecundity) from 1991-2013 was 0.42 with a range of 0.05 to 1.04 (Higley and Mendia 2013). During 2011, 2012 and 2013 HUP showed unusually low reproductive rates of 0.05, 0.13, and 0.06, respectively. In 2013, adult survival was approximately 0.8 on HUP (Higley and Mendia 2013), which is lower than that reported by Forsman et al. (2011). Annual apparent survival for territories surveyed on NWC averaged 0.848 for 1985-2014 (Franklin et al. 2015). Reproductive rate has also been reported for private timberlands outside of the demographic study areas, although monitoring and analysis approaches are not standardized as in the eleven demographic study areas, so direct comparisons are not possible. Humboldt Redwood Company reported a reproductive rate (number of young per pair) of 0.49 in 2014 (HRC 2015) and Mendocino Redwood Company reported a reproductive rate of approximately 0.12 in 2014 (MRC 2014). HRC (2013) noted a drop in reproductive rate since 2009. These more recent estimates of reproductive rate and survival since the last demographic meta-analysis (Forsman et al. 2011) are consistent with a continued decline within the demographic study areas in California.

As mentioned in the Life History section, most Spotted Owls do not breed every year and annual variation in reproductive effort and success is thought to be related to local weather conditions and fluctuations in prey abundance. This results in most areas having high variation in reproductive success between good years and bad years and can be seen in modeled rates of fecundity (Forsman et al. 2011). In the coastal portion of the Northern Spotted Owl range in California, many areas reported consistently low reproductive success from 2011-2013, including some of the lowest reproductive success rates on record in 2013. This is despite weather conditions in 2013 that would typically support good reproductive success. This was observed on many timber company lands (Calforests 2014, HRC 2014, GDRC 2015), tribal lands (Higley and Mendia 2013), and National Park land (Ellis et al. 2013). The reason for this widespread pattern of low reproductive success is not known.

In addition to providing rigorous estimates of survival, productivity, and population change across much of the range of the Northern Spotted Owl, the large amount of data and the regular demographic analyses allow for investigation of potential associations between population parameters and covariates that might explain estimates and trends (Forsman et al. 2011). Potential explanatory variables included in modeling during the most recent analysis of fecundity, survival, and λ included multiple weather and climate covariates, a habitat covariate, a Barred Owl covariate, and several other broad geographic

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covariates. Unlike studies that have modeled vital rates and potential explanatory variables at the scale of individual owl territories (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005), the meta-analysis evaluates covariates as an average effect across large study areas. The Barred Owl covariate was evaluated as the proportion of Northern Spotted Owl territories in each study area that had Barred Owls detected within a 1-km (0.62 mi) radius of activity centers. The habitat variable was the proportion of “suitable habitat” (based on Davis and Lint (2005), but generally characterized as containing large overstory conifers (dbh > 50cm) and canopy closure >70% in the study area). Although modeling average effect across large study areas is not as powerful at detecting effects that are influential at the territory scale (e.g., presence of Barred Owl or habitat conditions), data limitations required a coarser evaluation at the broad scale of the demographic analysis in order for methods to be consistently applied across study areas (Forsman et al. 2011). The broad demographic analysis found relatively weak associations between the amount of habitat and demographic rates, and somewhat larger effects of Barred Owl. These results, and those from more powerful territory-based studies, are discussed in the Habitat Requirements section and in the Threats section of this report.

Occupancy

Occupancy data are less resource-intensive to collect compared to data required to estimate the demographic parameters discussed above. Estimation of survival and reproduction requires the capturing and banding of owls at known sites, and multiple annual visits to all sites in order to recapture or re-sight owls, and to determine reproductive status. Occupancy data is based on the presence or absence of owls from known sites, and depending on the objectives of the monitoring does not necessarily require the monitoring of all sites each year. Due to this reduced requirement in survey effort and the necessity to visit known owl sites during pre-timber harvest monitoring, this type of data has frequently been collected and reported by timber companies and by other landowners (e.g. National Parks).

Although occupancy might appear to provide a substitute for estimates of survival, reproduction, or the rate of population change, it is not always appropriate to use an apparently stable occupancy rate to suggest a stable population size. As explained by Forsman et al. (1996),

“...it is possible that in a declining population, observed densities of territorial owls might not change during early years of the decline simply because territorial owls that died could be replaced by floaters (owls without territories) (Franklin 1992). Thus, significant changes in density of territorial owls might not become apparent for many years, especially if the rate of population decline was small (e.g., 1-2% per year).”

Therefore, a lack of a significant decline in observed owl numbers cannot necessarily confirm or refute estimates of survival or λ . Although little is known about the floater population of Northern Spotted Owls at any study area, other than that they exist and that they do not readily reply to broadcast calling, the number of floaters is finite. The perception of population stability due to establishment of territories by floaters cannot continue indefinitely in a constantly shrinking population. Depending on the rate of population decline (λ), the phenomenon should gradually disappear as the floater population is

Comment [A19]: Note to external reviewers:
The ongoing demographic analysis covering all survey years through 2013 will include occupancy modeling for the first time. Though we have included some preliminary results in this report when available (cited as “Dugger et al. in review”), we will update prior to finalizing if the full publication becomes available.

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depleted. If a study area has a relatively robust population of floaters, or if emigration into the study area occurs, the local population can decline for some time before being detected through declines in occupancy. Although declines in occupancy can indicate a reduction in local abundance when survey efforts are consistent over time (Bigley and Franklin 2004), a stable occupancy rate may not necessarily indicate that a population is stable.

Higley and Mendia (2013) observed inflated rates of occupancy on the Hoopa Valley Indian Reservation, and suggested that if owls are not color banded, it may be difficult to interpret stable occupancy rates. The authors believe that inflation of observed occupancy rates may be more likely in areas where Barred Owls are present and displace Spotted Owls:

“Furthermore, because our owls are color banded, we know that they are being observed in more than one territory per season... They are moving vast distances (several miles). Due to this movement, we may be seeing an inflated occupancy (use) rate on the landscape that is well above the actual rate. If this behavior exists in study areas without color-banded owls, there would be no way to determine whether owls in multiple sites were in fact the same individual.”

Although an evaluation of occupancy rates has not been included in previous demographic analyses, the authors of the most recently completed analysis note that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning, and few territorial owls could be found on some of the study areas in 2008 (Forsman et al. 2011). This is an important consideration in interpreting results of the demographic analysis because estimates of fecundity and survival rates are independent of population size. The estimated rates are averages for all owls in a study area and so do not incorporate any measure of population size. If a study area experiences a declining number of territorial owls, which on average are experiencing reductions in rates of fecundity, the result will be far fewer owls produced each year. Even if Northern Spotted Owls at a given study area experience stable rates of fecundity over time, areas with declining occupancy rates will produce fewer young overall. This phenomenon might also explain the relatively weak effect of Barred Owls on fecundity at some study areas (see discussion of Barred Owl in Threats section). If Northern Spotted Owls become displaced by Barred Owls, they are less likely to be detected (either because of increased mortality or because they are non-territorial and non-responsive to calls). Any Northern Spotted Owls not displaced may continue to breed at historic levels, resulting in no detectable reduction in fecundity on average, or they may breed at some unknown level in sub-prime habitat and remain undetected. However, the net effect is that fewer Northern Spotted Owls are produced (Forsman et al. 2011).

In order for estimates of occupancy to be valid, survey efforts must be consistent over time and the detection probability (the probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead to high variation in detection probability which can skew estimates of occupancy if not accounted for. Ideally the owl population would also be banded in order to address the concern of inflated occupancy rates observed by Higley and Mendia (2013), at least in areas where Barred Owl is present. The ongoing demographic analysis using data from the eleven demographic study areas and covering all survey years through 2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have declined at all three California study areas, with 32-

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1546 37% declines from 1995-2013 (Dugger et al. in review). All demographic study areas in Washington and
1547 Oregon have also experienced declines in occupancy, which is consistent with previous reports from
1548 these areas (Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011, Davis et al. 2013). Occupancy rates in
1549 Washington have declined by as much as 74% (Dugger et al. in review). Occupancy rates are a balance
1550 between rates of local territory extinction and rate of colonization. Barred Owls were shown to have a
1551 strong effect on occupancy by increasing the local territory extinction rate (Dugger et al. in review).
1552 There is also some evidence of that Northern Spotted Owl will not reoccupy empty sites if Barred Owls
1553 are present. Preliminary results also show a positive effect of habitat on colonization rates, and a
1554 negative effect of habitat in the core area on extinction rates (i.e. less habitat in the core area leads to
1555 higher extinction rate) (Dugger et al. in review).

1556 Outside of the three California demographic study areas, studies that have compiled robust datasets
1557 suitable for evaluation of Spotted Owl site occupancy in California are rare. In the southern Cascades
1558 and interior Klamath provinces of California, where there are no demographic study areas, Farber and
1559 Kroll (2012) compiled data from 1995-2009 using a consistent and rigorous annual survey effort at 63
1560 Northern Spotted Owl sites. Occupancy modeling showed that simple and pair Spotted Owl occupancy
1561 probabilities declined approximately 39% over the 15 year period; site occupancy for any owl declined
1562 from 0.81 (0.59–0.93) to 0.50 (0.39–0.60), and pair occupancy declined from 0.75 (0.56–0.87) to 0.46
1563 (0.31–0.61). In addition to providing estimates of occupancy from the interior of the range in California
1564 that is relatively understudied, this study also provides a rigorous assessment of occupancy trends on
1565 private timberlands.

1566 As an example of declining populations at California demographic study areas, the number of observed
1567 owls on NWC has declined from a high of 195 owls in 1992 to low counts of 62-67 owls since 2012
1568 (Franklin et al. 2015). At HUP, the number of owls observed between 1992 and 2006 was between 60-70
1569 owls each year; a steep decline since then has resulted in only 30 owls observed in 2013 (Higley and
1570 Mendia 2013). At the GDR density study area, the number of occupied sites declined from about 120-
1571 140 sites for years 1992-2004 to just over 80 occupied sites in 2008 (exact numbers not available; GDRC
1572 2015). A partial recovery in number of occupied sites led to about 110 occupied sites by 2012; the
1573 authors attributed this increase to removal of Barred Owls and an increase in suitable habitat (GDRC
1574 2015). Several study areas north of California have also undergone dramatic declines [in site occupancy](#).

1575 In the 97,000 acre Redwood National and State Parks, as many as 40 Northern Spotted Owl activity
1576 centers were identified during the 1990s. Occupancy rates are not available for the parks. However, by
1577 2001 a large proportion of activity centers had become inactive, and subsequent intensive surveys
1578 revealed that most historical Spotted Owl territories now appear to be occupied by Barred Owls
1579 (Schmidt 2013). Data through 2012 indicated that at least 58 Barred Owl sites occurred within the parks,
1580 not including areas with single detections of Barred Owls. In 2012, Northern Spotted Owls were
1581 detected at just four territories in the parks, with only one pair observed; this was also the second
1582 consecutive year with no known reproduction of Northern Spotted Owl in the parks (Schmidt 2013).

1583 In contrast to the above studies at demographic study areas and at other well-monitored areas that
1584 showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the

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study area, several industrial timber companies have concluded that Northern Spotted Owl occupancy rates have been stable on their lands, and that this indicates stable populations (Calforests 2014). In 2014, the California Forestry Association hosted a Northern Spotted Owl Science Forum, to which members of the association were invited to present on monitoring efforts and status of Spotted Owls on their property. Twelve landowners, timber management companies, and non-profit groups presented on various aspects of timber operations as they relate to Northern Spotted Owls. Presentations included data on Northern Spotted Owl surveys, numbers, and population parameters, although the information presented varied by participant. Reports on estimated occupancy rates were included in many presentations and are summarized in Table 8 for nine companies.

As discussed above, valid estimates of occupancy require consistent survey efforts over time, and modeling of occupancy rate must take into account detection probability. These requirements were rarely met in the occupancy estimates and trends reported by the timber companies (Calforests 2014). There is no standardized monitoring protocol used across the timber companies, and methods employed have been highly variable. In some cases, the level of detail at which methods are described does not allow for evaluation of occupancy estimates.

Of nine companies reporting on some aspect of occupancy on their ownership, five reported a stable trend in occupancy with one company reporting that the population size is variable. Two companies reported a mix of stable, declining, or increasing occupancy, depending on the time period or the portion of the owl population assessed. In most cases the companies have reported on counts of occupied sites or on naïve estimates of occupancy (the proportion of surveyed sites that are occupied in a given year) without consideration of detection probability. Counts of occupied sites and detection probability are both dependent on survey effort. An example of this can be seen in data submitted by Mendocino Redwood Company, which shows a correlation between survey effort and estimates of occupancy.

Green Diamond Resource Company, as a participant in the rangewide coordinated demographic studies since 1990, has the longest history of banding and monitoring work among the companies. Results from Green Diamond Resource Company are included in the demography section. Although results on occupancy modeling are preliminary, modeling revealed a more than 30% decline in occupancy from 1995-2013 (Dugger et al. in review). A reduction in the rate of decline in recent years was attributed to the removal of Barred Owl from portions of the study area.

Humboldt Redwood Company also has a fairly long history of monitoring, with consistent methods being used since 2002 and banding being conducted since 2003 as part of the HCP monitoring program (HRC 2014). Monitoring under the Humboldt Redwood Company HCP samples a subset of the land ownership in each year. Twenty percent of lands are surveyed each year, with the entire property surveyed every five years. However, core sites are monitored annually, including determination of occupancy, whereas other sites are sampled on a rotating basis. Core sites were established to represent activity centers that have had a history of occupancy and reproduction, and the HCP provides higher habitat retention requirements for these core sites. Therefore, sites which are monitored annually are those which meet minimum habitat requirements and have a higher history of use by Northern Spotted Owls, resulting in a

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biased sample. The sampling scheme therefore results in biased estimates of occupancy for the ownership as a whole. Also, because the non-core sites are sampled on a rotating basis, a different set of sites is sampled each year. It is unclear how this rotating sampling scheme may affect reported trends in occupancy. The sampling scheme included in the Humboldt Redwood Company HCP has the benefits of less intensive annual survey requirements and the ability to focus survey effort on sites with upcoming timber harvest or other management actions in order to meet the requirements of the HCP, but limits the ability to accurately determine occupancy rate for the ownership as a whole.

Campbell Global, L.L.C. manages timber lands for multiple owners, and reported on occupancy rates for two ownerships in Mendocino County (Calforests 2014). All known active activity centers were surveyed annually to determine occupancy status. Occupancy was first presented using simple count data for years 2000-2013, with no apparent trend in occupancy over time. The Spotted Owl population was reported to be dynamic but stable on these ownerships. Campbell Global also presented preliminary results of modeled occupancy dynamics (including estimation of detection probability) using data from the same ownerships from 1990-2010. Modeling showed that occupancy probabilities for single Spotted Owls began to decline in 2003. Pair occupancy declined by 16-30% during the initial portion of the time period before stabilizing in 1997. These results show how simple counts or naïve estimates of occupancy will not necessarily reflect true occupancy rates.

The Mendocino Redwood Company is the only other company to model occupancy rates taking into account detection probability (Calforests 2014). As with the lands managed by Campbell Global, L.L.C., when occupancy was presented using counts or naïve estimates there was no apparent trend (years included were 2001-2013). However, when occupancy modeling was conducted for a subset of years 2001-2008, a slight decline in occupancy was found. Occupancy modeling was not conducted on data from more recent years.

The variability in methods used by companies, the tendency to report on counts or naïve estimates of occupancy without consideration of detection probability, the sometimes inconsistent methods used over time, along with the sometimes limited description of methods, makes it difficult to interpret the reported occupancy rates and trends for most companies. This leads to some difficulty in comparing reported rates in timber company reports to other published estimates of occupancy and does not support a strong finding that occupancy rates have been stable across these ownerships over time.

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1654 **Table 8.** Occupancy estimates as presented in the Northern Spotted Owl Science Compendium in 2014 by
1655 participating timber companies with ownership in the range of the Northern Spotted Owl in California. See text for
1656 caution in interpreting these results.

Company	Pair Occupancy in 2013	Reported Occupancy Trend
Humboldt Redwood Company (Humboldt County)	0.85 (pairs only)	Stable
Sierra Pacific Industries (mainly Siskiyou and Shasta counties)	No rate provided, reported 48 known sites occupied	Stable
Conservation Fund (Mendocino and Sonoma counties)	No rate provided, reported 23 known sites occupied	Stable
Michigan-California Timber Company (Siskiyou County)	0.48	Stable
Green Diamond Resource Company (Humboldt and Del Norte counties)	0.83	1998-2008 Declining 2009-2011 Increase ¹
Crane Mills (mainly Tehama and Shasta counties)	No rate provided, reported 38 known sites occupied	No trend in occupancy noted
Mendocino Redwood Company (Mendocino and Sonoma counties)	0.69	Stable
Fruit Growers Supply Company (mainly Siskiyou County)	Approximately 0.95	Variable
Campbell Global (Mendocino, Siskiyou and Shasta counties)	>0.85 and >0.80 (singles) >0.85 and >0.70 (pairs) (estimates from 2010 occupancy analysis on two ownerships in Mendocino County)	Declining Stable

¹ The increase in occupancy starting in 2009 was attributed to the start of Barred Owl removals from the study area.

1659 Source-Sink Dynamics

1660 Pulliam (1988) was the landmark publication on source-sink population dynamics. Since then,
1661 application of source-sink dynamics has been applied within many ecological studies to better
1662 understand movement (e.g., dispersal) interactions on the landscape while accounting for birth and
1663 death rates within population segments. Source populations are those in which reproduction exceeds
1664 carrying capacity thereby providing a surplus of individuals, whereas sink populations are those where
1665 mortality exceeds local reproduction (Pulliam 1988, Dias 1996, Watkinson and Sutherland 1995).
1666 Pseudo-sinks are populations that those populations that may be viable, but movement dynamics are
1667 difficult to distinguish based on complicated demographics and habitat connectivity (Watkinson and
1668 Sutherland 1995). These source-sink dynamics have been linked to habitat quality, generally with high

Comment [EMG20]: Start this section with a definition/explanation of what source-sink dynamics are and how they relate to meta-population dynamics.

Comment [EMG21]: Source-sink dynamics is also important for assessing population stability/viability across large landscapes or for species that may exhibit metapopulation dynamics.

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quality habitat producing source populations, and low quality habitat producing sink populations (Dias 1996). Protected areas may serve different functions for vulnerable species depending on habitat quality and connectivity (Hansen 2011). Understanding source-sink populations can give us insight into appropriate and effective management actions that may benefit species habitat and populations at a local or range-wide level. For the Northern Spotted Owl, such principles are key to understanding connectivity (quality and function) between populations and how these populations may affect one another.

By applying source-sink modeling techniques and utilizing the immense amount of data available on Northern Spotted Owl life history and demography, Schumaker et al. (2014) characterized Northern Spotted Owl movement dynamics between modeling regions and physiographic provinces noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). For California, the Northern Spotted Owl populations within the Klamath region (Klamath West and Klamath East modeling regions; California Klamath physiographic province) and the Inner California Coast Range modeling region were identified as source populations, while the California Coast Range and California Cascade physiographic provinces were identified as sink populations (Table 9). Source-sink strength was substantial for the East Cascade South modeling region (sink), Klamath East region (source), Inner California Coast region (source), California Coast province (sink), and California Klamath province (source).

Table 9. Source and sink attributes within modeling region and physiographic province found in California (adapted from Table 2 in Schumaker et al. 2014). Includes percent of modeled range-wide population for each location, whether the location is a source or sink, and the strength of the sink/source as a percent of the best range-wide source or worst range-wide sink.

Location	Percent of population	Source or Sink	Source-Sink Strength
<i>Modeling Regions</i>			
East Cascade South	3.8	Sink	100
Redwood Coast	16.4	Sink	28.1
Klamath West	20.0	Source	51.1
Klamath East	17.1	Source	97.9
Inner California Coast	21.7	Source	100
<i>Physiographic Provinces</i>			
California Coast Range	16.6	Sink	100
California Cascades	2.8	Sink	35.9
California Klamath	36.4	Source	100

Schumaker et al. (2014) evaluated movement and contribution to overall population growth rate within modeling region and physiographic province source locations range-wide. Data for source locations in California is summarized in Table 10 and graphically in Figure 8. Klamath modeling regions (Klamath West and Klamath East) provided a flux of individuals within (e.g., Klamath West to Klamath East), and to the Cascade modeling regions (East Cascade South and West Cascades South), Redwood Coast, and Oregon Coast. Percent of net flux was most notable from Klamath East to East Cascade South regions. The Inner California Coast modeling region provided a flux of individuals to Klamath and East Cascade South regions. The California Klamath province was identified as a source provided a flux of individuals

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1699 to the California Coast Range, California Cascades and Oregon Klamath provinces, with net flux most
1700 notable to the California Coast Range province.

1701 **Table 10.** Net Flux and $\Delta\lambda^R$ for modeling region and physiographic province source locations in California (adapted
1702 from Table 3 in Schumaker et al. 2014). Net Flux represents movement from one location to another. $\Delta\lambda^R$
1703 represents the change in overall population growth rate.

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
<i>Modeling Regions</i>			
Klamath West	Redwood Coast	36.2	3.9
	Oregon Coast	49.5	45.9
	Klamath East	12.7	19.1
Klamath East	East Cascade South	100	85.1
	West Cascades South	36.0	27.4
Inner California Coast	Klamath West	44.4	28.3
	Klamath East	19.7	18.4
	East Cascades South	30.4	22.4
<i>Physiographic Provinces</i>			
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

1704
1705 Schumaker et al. (2014) results suggest that California's population of Northern Spotted Owls is a
1706 significant component of and source to the range-wide population. As a source, the Klamath region
1707 populations provide a source of owls to sink populations on the Coast and Cascade ranges. This concept
1708 is central to protection of owl habitat, especially dispersal habitat, for the continued persistence of
1709 Northern Spotted Owls across their range.

Existing Management

Land Ownership Patterns in Northern Spotted Owl Range

1713 The laws and regulations governing management of forests in the range of the Northern Spotted Owl
1714 vary depending on ownership. For this reason, the following discussion on existing management is
1715 partitioned based on ownership, with lands governed by a common set of regulations. In general,
1716 federal timberlands in the range of the Northern Spotted Owl are governed by the NWFP, with some
1717 federal ownership subject to more restrictive management (e.g., National Parks). Although tribal lands
1718 are subject to federal regulations for timber management, the tribes in the range of the Northern
1719 Spotted Owl in California have developed Forest Management Plans (FMPs) and are discussed
1720 separately. Nonfederal lands in California must comply with the Forest Practice Rules for commercial
1721 timber harvest. There are several options for complying with the Forest Practice Rules when developing
1722 a THP depending on several factors including, but not limited to, size of ownership, presence of Spotted
1723 Owl activity centers, and qualification for an exemption. We present these options below and discuss
1724 the most important options in greater detail.

Comment [EMG22]: Citation?

Comment [EMG23]: Define this acronym.

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Federal lands contain less than half of the total forest land in the range of the Northern Spotted Owl (Mouer et al. 2011). Of an estimated 14.3 million acres of forested lands within the Northern Spotted Owl range in California, 6.4 million acres are publicly owned and 7.8 million acres are privately owned (2.3 million acres industrial and 5.5 million acres non-industrial) (Calforests 2013). Federal lands in the Northern Spotted Owl range in California are more concentrated in the interior portion of the range, with most USFS and BLM land occurring in the Klamath and Cascades provinces (Figure 9). The majority of the California Coast Province is under private ownership, though large tracts of public land occur along the coast, including both State and National parks. The most interior portion of the Northern Spotted Owl range in California (Cascades and eastern portion of Klamath provinces) has a combination of federal and private land, sometimes in a checkerboard pattern as a result of historical railway land grants (Figure 9). Tribal lands in California collectively represent 167,401 acres in the range of the Northern Spotted Owl and are mostly within the Coast Province and the western portion of the Klamath Province.

Critical Habitat Designation

In 2012, the USFWS revised the critical habitat designation for the Northern Spotted Owl (USFWS 2012). The purpose of critical habitat is to designate land distributed within the entire range of the Northern Spotted Owl that provides “features essential for the conservation of a species and that may require special management”, which includes forest types supporting the needs of territorial owl pairs throughout the year, including nesting, roosting, foraging, and dispersal habitat (USFWS website - <http://www.fws.gov/oregonfwo/species/data/northernspottedowl/CriticalHabitat/default.asp>). Critical habitat was identified using a modeling framework that considered both habitat requirements and demographic data, and considered uncertainties such as impacts of Barred Owl, climate change, and wildfire risk. Range wide, 9.29 million acres of critical habitat is on federal land and 291,570 acres is on state land. All private lands and the majority of state lands were excluded from the designation. A map of critical habitat for California is shown in Figure 10, which includes 2,014,388 acres on federal land, and 49,542 acres on state land. For management purposes, critical habitat only affects federal actions and do not provide additional protection on non-federal lands, unless proposed activities involve federal funding or permitting.

Federal Lands

Northwest Forest Plan

In the early 1990s, concern was raised regarding the adequacy of federal plans to protect the Northern Spotted Owl. Litigation resulted in a court injunction on harvest of owl habitat (mature and old-growth forest). In 1993, President Clinton directed the Forest Ecosystem Management Assessment Team (FEMAT) to develop long-term management alternatives for maintaining and restoring habitat conditions to maintain well-distributed and viable populations of late-successional- and old-growth-related species. The FEMAT was instructed to maintain and restore habitat conditions for the Northern Spotted Owl (as well as the Marbled Murrelet). The FEMAT was also instructed to maintain and restore

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habitat conditions to support viable populations, well-distributed across current ranges, of all species known or reasonably expected to be associated with old-growth habitat conditions; and to maintain or create a connected, interactive, old-growth forest ecosystem on federal lands (FEMAT 1993; Thomas et al. 2006). In developing alternatives, the members of FEMAT relied heavily on recently completed conservation assessments, including a regional conservation strategy for the Northern Spotted Owl (Thomas et al. 1990). The analysis of the FEMAT alternatives in a final supplemental environmental impact statement (USDA and BLM 1994a) led to adoption of the land-allocation strategy contained in the record of decision (USDA and BLM 1994b), hereinafter referred to as the Northwest Forest Plan. The NWFP amended nineteen existing USFS and seven BLM resource management plans within the range of Northern Spotted Owl. The intention of the NWFP is to improve current conditions and alter past practices that were detrimental to late-successional species by protecting large blocks of remaining late-successional and old-growth forests, and to provide for the regrowth and replacement of previously harvested late-successional forest stands. To help facilitate decision-making and issue resolution during the implementation of the NWFP, the Regional Ecosystem Office was formed and is made up of members from USFS, BLM, National Park Service (NPS), and Environmental Protection Agency (EPA).

The NWFP covers approximately 24 million acres of federal land within the range of the Northern Spotted Owl, about 67% of which are allocated in one of several “reserved” land use designations (see discussion of designations and Table 11). In California, approximately 3.5 million acres of federal lands fall under the NWFP as reserved land. This is approximately 6 percent of the 57 million acres of forested habitat within the Northern Spotted Owl’s California range. Reserved lands are intended to support groups of reproducing owl pairs across the species’ range. Unreserved land is defined as the federal land between reserved lands and is intended to provide recruitment of new owls into the territorial populations and is important for dispersal and movement of owls between larger reserves.

Table 11. Land-use allocations in the Northwest Forest Plan (adapted from Thomas et al. 2006)

Land-use allocation	Approximate Acres (%)
Congressionally reserved areas	7,323,783 (30)
Late-successional reserves	7,433,970 (30)
Managed late-successional reserves	102,242 (1)
Adaptive management areas	1,522,448 (6)
Administratively withdrawn areas	1,477,730 (6)
Riparian reserves	2,628,621 (11)
Matrix	3,976,996 (16)
<i>Total</i>	<i>24,465,790 (100)</i>

Reserved land includes late-successional reserves (LSRs), managed late-successional areas (managed LSAs), congressionally reserved lands, and larger blocks of administratively withdrawn lands. The LSRs cover about 30% of the NWFP area and were located to protect areas with concentrations of high-quality late-successional and old-growth forest on federal lands and to meet the habitat requirements of the Northern Spotted Owl (Thomas et al. 2006). Most LSRs were designed to accommodate at least 20 pairs of Northern Spotted Owls (FEMAT 1993). Timber harvesting is generally prohibited in LSRs.

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1793 However, silviculture treatments (including thinning in stands less than 80 years old west of the
1794 Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit
1795 the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging
1796 is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events
1797 such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that
1798 were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National
1799 Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district
1800 plans as being withdrawn from timber production and include recreational and visual areas, back
1801 country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily
1802 in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with
1803 smaller amounts of reserved lands on the coast (Figure 11).

1804 Unreserved land includes the matrix, adaptive management areas (AMAs), riparian reserves, small tracts
1805 of administratively withdrawn lands, and other small reserved areas such as 100-acre owl core areas.
1806 The matrix represents the federal land not included in any of the other allocations and is the area where
1807 most timber harvesting and other silviculture activities occur. However, the matrix does contain non-
1808 forested areas as well as forested areas that may be unsuited for timber production. Three of the major
1809 standards and guidelines for matrix land management are: (1) a renewable supply of large down logs
1810 must be in place; (2) at least 15% of the green trees on each regeneration harvest unit located on
1811 National Forest land must be retained; and (3) 100 acres of late-successional habitat around owl ACs
1812 must be protected (USDA and BLM 1994b). Timber harvesting is allowed within AMAs and like the
1813 matrix lands, AMAs are subject to the standards in the NWFP and in individual forest and district plans.
1814 Riparian reserves are a system of reserves defined by a set distance on each side of perennial and
1815 intermittent streams (Thomas et al. 2006) and may provide dispersal habitat for Northern Spotted Owls.

1816 Standards and guidelines for the management of both reserved and unreserved lands are described in
1817 the Record of Decision associated with the NWFP (USDA and BLM 1994b, Attachment A). A summary of
1818 management on each land use designation is provided below.

1819 Late Successional Reserves:

1820 Before habitat manipulation activities occur on LSRs, management assessments must be prepared.
1821 These assessments include a history and inventory of overall vegetative conditions, a list of identified
1822 late-successional associated species existing within the LSR, a history and description of current land
1823 uses within the reserve, a fire management plan, criteria for developing appropriate treatments,
1824 identification of specific areas that could be treated under those criteria, a proposed implementation
1825 schedule tiered to higher order plans, and proposed monitoring and evaluation components to help
1826 evaluate if future activities are carried out as intended and achieve desired results. The following
1827 standards must be followed for timber management activities in LSRs:

- 1828 • West of the Cascades – No timber harvest is allowed in stands over 80 years old. Thinning (pre-
1829 commercial and commercial) may occur in stands up to 80 years old in order to encourage
1830 development of old-growth characteristics.

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- East of the Cascades and in California Klamath Province – Silviculture activities should be designed to reduce catastrophic insect, disease, and fire threats. Treatments should be designed to provide fuel breaks but should not generally result in degeneration of currently suitable owl habitat or other late-successional conditions. Risk reduction activities should focus on young stands but activities in older stands may be undertaken if levels of fire risk are particularly high.
- Salvage in disturbed sites of less than 10 acres is not appropriate. Salvage should occur only in stands where disturbance has reduced canopy closure to less than 40%. All standing living trees should be retained, including those injured (e.g., scorched) but likely to survive. Snags that are likely to persist until late-successional conditions have developed should be retained. Appropriate levels of coarse woody debris should be retained. Some salvage will be allowed when it is essential to reduce fire risk or insect damage to late-successional forest conditions.

Managed Late Successional Areas:

Innovative silviculture techniques may be applied in managed LSRs. Proposed management activities are subject to review by the Regional Ecosystem Office, although some activities may be exempt from review. Within managed LSRs, certain silviculture treatments and fire hazard reduction treatments are allowed to help prevent complete stand destruction from large catastrophic events such as high intensity, high severity fires; or disease or insect epidemics. Managed LSAs should have management assessments as described for LSRs. Standards and guidelines for multiple-use activities other than silviculture are the same as for LSRs.

Congressionally Reserved Lands:

These lands are managed according to existing laws and guidelines established when the lands were set aside, and are generally managed to preserve natural resources (e.g., The National Park Service Organic Act of 1916, the National Parks Omnibus Management Act of 1998).

Administratively Withdrawn Areas:

There are no specific timber/silviculture standards and guidelines associated with administratively withdrawn areas. These areas have been identified as withdrawn from timber production in forest or district plans.

Riparian Reserves:

Riparian Reserves are managed to meet objectives of the Aquatic Conservation Strategy to help protect fish habitat and restore water quality. Timber harvest is prohibited within riparian reserves, including fuelwood cutting and salvaging (although some exceptions are made). Fuel treatment and fire suppression strategies and practices implemented within these areas are designed to minimize disturbance.

Matrix Lands:

Matrix lands are open to timber harvest subject to the standards in the NWFP and in the individual forest and district plans. The objective for Matrix lands is to “provide coarse woody debris well distributed across the landscape in a manner which meets the needs of species and provides for ecological functions” (USDA and BLM 1994b). Standards for Matrix lands in the NWFP include:

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- Coarse woody debris that is already on the ground is retained and protected from disturbance to the greatest extent possible during logging and other land management activities that might destroy the integrity of the substrate.
- Retention of at least 15% of the area associated with each cutting unit (stand).
- In general, 70% of the total area to be retained should be aggregates of moderate to larger size (0.5 to 2.5 acres or more) with the remainder as dispersed structures (individual trees, and possibly including smaller clumps less than 0.5 acres). Patches and dispersed retention should include the largest, oldest live trees, decadent or leaning trees, and hard snags occurring in the unit. Patches should be retained indefinitely (i.e., through multiple rotations to provide support for organisms that require very old forests).
- 100 acres of the best Northern Spotted Owl habitat must be retained as close to the nest site or owl activity center as possible for all known activity centers located on federal lands in the matrix and AMAs. These areas are managed in compliance with LSR management guidelines and are to be maintained even if Northern Spotted Owls no longer occupy them.

Adaptive Management Areas:

AMAs were intended to be focal areas for implementing innovative methods of ecological conservation and restoration, while meeting economic and social goals. Although there have been some successes in experimentation, most AMAs have been managed similarly to Matrix lands (Thomas et al. 2006). The NWFP established 10 AMAs, two of which are in California: Goosenest in northeastern California and Hayfork, which is located mostly in the Klamath province. One of the primary goals of the Goosenest AMA is to investigate means of accelerating the development of late-successional forest properties in pine forests. Mechanical treatments (forest thinning) and prescribed fire have been used experimentally to evaluate effect on development of late-successional forest properties in pine forests (Ritchie 2005). The emphasis for Hayfork is to investigate effects of forest management practices on the landscape, including partial cutting, prescribed burning, and low-impact approaches to forest harvest.

Standards and guidelines for LSRs and Congressionally Reserved Areas are followed where they fall within AMAs.

Section 7 Consultations

Section 7 of the Endangered Species Act requires all federal agencies to consult with the USFWS to ensure that any timber management action authorized, funded, or carried out by federal agencies is not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat (16 U.S.C. § 1536 subd. (a); 50 C.F.R. § 402). Section 7 requires the permitting instrument (i.e., biological opinion or letter of concurrence) to include measures to minimize the level of take to Northern Spotted Owl. Examples of take minimization measures may include:

- Restricted use of heavy equipment during the breeding season
- Retention of larger trees owl nesting/roosting and foraging habitat

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- 1908 • Retention of large snags and down logs within thinning units
- 1909 • Retention of hardwoods
- 1910 • Limited thinning within Riparian Reserves
- 1911 • Monitoring and surveys for Northern Spotted Owl throughout projects
- 1912

1913 *Forest Stewardship Contracting*

1914 The Agricultural Act of 2014 (“Agricultural Act of 2014, Section 8205, Stewardship End Result
1915 Contracting Projects”) grants the USFS and BLM authority to enter into stewardship contracting with
1916 private persons or public entities to perform services to “achieve land management goals for the
1917 national forests or public lands that meet local and rural community needs” (USFS 2009). Agreements
1918 allow contractors to remove forest products (goods) in exchange for performing restoration projects
1919 (services), the cost of which is offset by the value of the goods. Agreements may extend for up to 10
1920 years.

1921 Since the new authority became law, the USFS has awarded more than 30 stewardship projects. It is
1922 unknown how many USFS stewardship projects are in California. There are some inconsistencies in
1923 information regarding the number of BLM stewardship projects. The BLM Stewardship Contracting Fact
1924 Sheet
1925 ([http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.da](http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf)
1926 [t/stcontrBLM_Fact0115.pdf](http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf)) lists two stewardship projects that do not occur in California. However, the
1927 BLM website (http://www.blm.gov/wo/st/en/prog/more/forests_and_woodland/0.html) lists three
1928 forest stewardships in California: Weaverville Community Forest, South Knob, and Hobo Camp.

1929 *Bureau of Land Management*

1930 The standards and guidelines from the NWFP apply except where existing resource management plans
1931 are more restrictive or provide greater benefits to late-successional forest related species.

1932 Headwaters Forest Reserve

1933 Headwaters Forest Reserve is located in the north coast region of California and was purchased by the
1934 Secretary of Interior and the State of California in 1999 to preserve a large stand of old-growth redwood
1935 forest. The Headwaters Forest Reserve Resource Management Plan (USDOI et al. 2003; USDOI and BLM
1936 2004a) was developed with the goal to restore and maintain ecological integrity and to study ecological
1937 processes within the Reserve to improve management. Recreation and other management activities are
1938 constrained as necessary to be consistent with that primary goal. Old-growth forest habitat within the
1939 Reserve is managed to leave those systems undisturbed as core areas of optimal habitat. Second-growth
1940 forests are managed using tree thinning for restoration of old-growth characteristics. Priority is given to
1941 revegetating watershed restoration sites in old-growth areas and to treating harvested stands with old-
1942 growth remnants. Harvested stands that comprise early-mature and older seral stages (i.e., stands with
1943 an average stem diameter over 12 inches) are generally not thinned. Density-management treatments

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1944 do not yield commercial forest products; all biomass is left on-site and may be lopped and scattered,
1945 piled and burned, or chipped. Chain saws, mechanical brush cutters, and chippers may be used.
1946 Permanent or temporary roads or skid trails are not developed for access for treatment sites, but
1947 temporary access routes may be developed where they will be subsequently removed during watershed
1948 restoration activities.

1949 The desired outcome for Northern Spotted Owl is protection of existing habitat and expansion of
1950 suitable habitat for nesting, roosting, foraging, and dispersal habitat at the Reserve. The Resource
1951 Management Plan allows for the restoration of up to 2,757 acres of previously harvested stands. No
1952 suitable habitat for Northern Spotted Owl is to be removed or degraded during watershed restoration,
1953 forest restoration, or trail development. To the extent practicable, activities will be buffered from
1954 Northern Spotted Owl nesting habitat during the period of February 1 through July 31 by the use of
1955 vegetative screening or topographic screening and establishment of seasonal operating periods or a
1956 distance buffer of up to 0.25 mile. Off trail hiking is prohibited year-round.

1957 Fuels in second-growth forests are managed through tree thinning with materials lopped and scattered,
1958 piled and burned, or chipped; broadcast burning is not employed within the Reserve. Fuels are not
1959 managed in old-growth forests and generally not in second-growth forest once they achieve early-
1960 mature seral stage. Fire suppression uses a minimum-impact strategy. In second-growth forests dozers
1961 may be used; resource damage will be minimized and full rehabilitation of dozer fire lines will be
1962 required after fire suppression. In old-growth forests road access will be limited to existing road
1963 systems; hand crews or helicopter bucket drops may be deployed to attempt to contain fire.

1964 King Range National Conservation Area

1965 The King Range National Conservation Area (NCA) is located along the northern California coast about
1966 sixty miles south of Eureka and 200 miles north of San Francisco. The King Range NCA Management Plan
1967 (USDOI and BLM 2004b; USDOI and BLM 2005) applies to 68,000 acres of forested land. All of the
1968 forested lands in the planning area have been designated as a LSR under the NWFP, and therefore must
1969 be managed to promote late-successional forest characteristics. All active forest management activities
1970 in the Management Plan are focused only in the Front Country Zone, 25,661 acre zone representing a
1971 broad mix of uses and tools for management. Forest management activities in this zone are intended to
1972 develop more natural stand characteristics in areas that were previously harvested, improve watershed
1973 and fisheries health, and protection from wildfire risk. Some of these previously-logged areas have
1974 burned in high intensity fires, or are at risk for future fires of stand-replacing intensity. The primary goal
1975 in silvicultural treatments is to increase the Douglas-fir component in tanoak dominated stands, and
1976 “fireproof” this Douglas-fir component so that it has a greater chance to reach maturity.

1977 The Management Plan calls for the protection of sufficient Northern Spotted Owl habitat to attract and
1978 support 20 breeding pairs within the King Range NCA, as well as monitoring of known owl sites and
1979 periodic surveys in suitable habitat. At the time of the Management Plan development (2004), there
1980 were 12-14 known Spotted Owl activity centers in the King Range NCA. No timber harvests takes place in
1981 those activity centers.

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1982 *National Park Service*

1983 Redwood National and State Parks

1984 Redwood National Park was established in 1968 and was expanded in 1978. Three California state parks
1985 established in the 1920s—Prairie Creek Redwoods State Park, Del Norte Coast Redwoods State Park, and
1986 Jedediah Smith Redwoods—were included within the 1968 congressionally designated national park
1987 boundary. Since 1994, the four park units have been managed jointly as Redwood National and State
1988 Parks (RNSP) to the greatest extent possible, although the state parks are administered by the California
1989 Department of Parks and Recreation and the national park is administered by the NPS. Collectively,
1990 RNSP covers approximately 131,983 acres of land in northwest California reaching from the shoreline of
1991 the Pacific Ocean to the mountains of the Coast Range.

1992 In 2000, a joint federal-state management plan was developed to provide a clearly defined, coordinated
1993 direction for resource preservation and visitor use and a basic foundation for managing these four parks
1994 (NPS 2000a, NPS 2000b). There are nine management zones within the RNSP, each with different types
1995 and levels of use, management, and facilities that are allowed. Three zones cover most of the combined
1996 park area – the two backcountry zones (42.1% mechanized and 13.3% nonmechanized), and the
1997 primitive zone (32.6%). The backcountry zones and primitive zone have the most restricted access, and
1998 resource modification and degradation from visitor use in these zones is low. The remaining 12% of the
1999 park area is made up of six relatively small zones which are managed for various resources and for
2000 visitor operational needs.

2001 The RNSP General Management Plan (NPS 2000b) includes programs for watershed restoration,
2002 vegetation management, cultural resource management, interpretation and education, and facility
2003 development. Under the watershed restoration program, abandoned logging roads that contribute
2004 unnatural amounts of sediments into streams or threaten redwoods along park streams will be removed
2005 or treated to reduce erosion. The vegetation management program includes use of silvicultural
2006 techniques in second-growth forests to accelerate the return of characteristics found in old-growth
2007 forests and management of fire to support resource management strategies, including restoration of
2008 fire in old-growth forests.

2009 Prior to timber removal, the NPS will evaluate trees that are potential suitable nesting habitat for
2010 Northern Spotted Owl. The NPS take measures to reduce noise disturbance and loss of suitable habitat
2011 within one mile of occupied and unsurveyed potential suitable nesting habitat by operating outside the
2012 breeding season, using quiet equipment, or by implementing daily limited operating periods for heavy
2013 equipment during the breeding season. Protective buffer zones are used around known owl nest sites
2014 where visitor use activities are likely to result in disturbance.

2015 In 1978, Congress expanded RNSP to include 38,000 acres that had been logged between 1950 and 1978
2016 using clearcut tractor logging. With the expansion of the RNSP, commercial operations including active
2017 forest management and silviculture thinning ceased which resulted in second-growth forest conditions
2018 “considered unhealthy from both a silviculture and an ecological standpoint” (NPS 2008, NPS 2009a).

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2019 Many of the second-growth forest stands were primarily high-density, even-aged Douglas-fir stands with
2020 little canopy structure and no understory development. The focus of second-growth forest restoration is
2021 to reduce stand density (thinning) to promote growth of remaining trees while protecting adjacent old-
2022 growth forests, as well as maintaining water quality in riparian habitats, minimizing tanoak tree
2023 disturbance, and minimizing excessive fuel build-up on the forest floor.

2024 In 2009, the NPS planned to apply thinning prescriptions throughout 1,710 acres in the South Fork of
2025 Lost Man Creek, with the prescription dependent upon slope steepness, available road access, presence
2026 of streams and wetlands, tanoak density, and proximity to old growth forest.

2027 The USFWS issued a Biological Opinion (file number 8-14-2004-2133 81331-2008-F-00027, dated
2028 December 19, 2007) that concurred with the NPS determination that the project may affect but is not
2029 likely to adversely affect the Northern Spotted Owl. The project was expected to alter approximately
2030 1,539 acres of suitable Northern Spotted Owl habitat. However, the habitat was considered poor quality
2031 and the short-term adverse effects on owls from habitat alteration to be negligible. The project was
2032 expected to have long-term benefits for Northern Spotted Owl due to retention and protection of
2033 deformed trees and snags, and habitat improvement through acceleration of development of late-
2034 successional forest structure.

2035 In 2011, Redwood National Park completed a project to thin about 1,700 acres of second growth forest
2036 in the South Fork of Lost Man Creek (near the community of Orick) to accelerate the restoration of old-
2037 growth characteristics and functions.

2038 The RNSP General Management Plan called for preparation of a comprehensive trail and backcountry
2039 management plan to guide the development of an expanded trail system and prescribe policies and
2040 regulations for the use of backcountry areas by hikers, bicyclists, and equestrians. The Trail and
2041 Backcountry Management Plan (NPS 2009b) details the construction of seven hiking trails totaling 14.6
2042 miles, establishment of two bike trails totaling 10.3 miles, and construction of two new backcountry
2043 camps. Avoidance and minimization measures during construction include above ambient noise
2044 producing work conducted outside of the marbled murrelet noise restriction period (March 24-
2045 September 15) and Northern Spotted Owl presence surveys prior to construction (NPS and CDPR 2013).

2046 Fire management in RNSP includes suppression of wildfires, prescribed fire, mechanical fuel reduction,
2047 fire ecology research and fire effects monitoring, and fire operations planning (NPS 2010a, NPS 2010b).
2048 Fire suppression preparations include installing water tanks, preparing access roads, and removing
2049 hazardous fuels. Management actions are designed to avoid or minimize adverse effects on listed,
2050 proposed, or candidate threatened or endangered species and minimizes the effects on sensitive
2051 species. The NPS has developed guidelines to reduce or eliminate potential adverse effects on sensitive
2052 species from fire suppression in RNSP.

2053 Point Reyes National Seashore and Muir Woods National Monument

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2054 The Point Reyes National Seashore (PRNS) was established in 1962 and is located along the coast just
2055 north of San Francisco. The General Management Plan and Environmental Impact Statement for PRNS
2056 are currently under development.

2057 Due to a better understanding of the role of fire in ecosystem preservation and reducing fire risk, in
2058 2004 the NPS proposed to revise PRNS's Fire Management Plan to expand the use of prescribed fire and
2059 mechanical treatment for all lands under its management NPS 2004). In 2006, the Operational Strategy
2060 for the Fire Management Plan was published (NPS 2006a). The planning area for the Fire Management
2061 Plan includes the 70,046-acre PRNS as well as 18,000 acres of the Northern District of Golden Gate
2062 National Recreation Area. The Fire Management Plan allows up to 3,500 acres per year to be treated
2063 using prescribed fire and mechanical treatments. Measures in Northern Spotted Owl habitat include:

- 2064 • Annually identify and map areas where Spotted Owls are nesting.
- 2065 • Protect occupied and previously used nest sites from unplanned ignitions.
- 2066 • Do not conduct prescribed burns within 400 meters of an occupied or previously used nest
- 2067 site.
- 2068 • Do not conduct mechanical treatments with mechanized equipment within 400 meters of an
- 2069 occupied or previously used nest site between February 1 and July 31 (breeding season).
- 2070 • Conduct post-treatment monitoring to ascertain any impacts.
- 2071

2072 Muir Woods National Monument is managed by the NPS as part of the Golden Gate National Recreation
2073 Area. The General Management Plan Environmental Impact Statement for the Golden Gate National
2074 Recreation Area and Muir Woods was completed in 2014 (NPS 2014). The Record of Decision was
2075 expected to be completed in spring 2014 but has not been completed to date.

2076 The Fire Management Plan for Muir Woods allows up to 595 acres to be treated per year using
2077 mechanical treatments and prescribed fire (NPS 2006b). Measures to protect Northern Spotted Owl
2078 include:

- 2079 • Treatment activities or any noise generation above ambient noise levels will not occur within
- 2080 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential
- 2081 Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as
- 2082 surveys conforming to accepted protocol have determined that the site is unoccupied or non-
- 2083 nesting or nest failure is confirmed.
- 2084 • Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially
- 2085 alter the percent cover of canopy overstory and will preserve multilayered structure. When
- 2086 shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy
- 2087 will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency
- 2088 vehicle clearance.
- 2089 • Prior to fire management activities, project areas will be surveyed for the presence of dusky
- 2090 footed woodrat nests. If feasible, woodrat nests will be protected.

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- 2091 • Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a
- 2092 determination is made that the native tree presents a clear hazard in the event of a fire or
- 2093 cutting is the only option to reduce high fuel loading.
- 2094 • The fire management officer will arrange for qualified biologists to conduct post-project
- 2095 monitoring to determine short- and long-term effects of fire management actions on activity
- 2096 centers if resources are available.
- 2097

2098 Tribal Lands

2099 Hoopa Valley Indian Reservation

2100 The Hoopa Valley Indian Reservation is the largest reservation in California encompassing 90,767 acres,
2101 and located in the northeastern corner of Humboldt County. The Hoopa Valley Tribe has recently
2102 adopted a revised Forest Management Plan (FMP) covering the period of 2011-2026 (Higley 2012). The
2103 annual allowable timber harvest has been determined to be 8.889 million board feet (MBF) net per year
2104 of conifer volume and 3.1 MBF net of hardwood volume to be harvested within the Reservation.
2105 Northern Spotted Owl habitat losses are expected from implementation of the FMP due to timber
2106 harvest, urban development, road construction, and prairie restoration. About 8,980 acres of roosting-
2107 foraging and nesting-roosting-foraging habitat are estimated to be lost to timber harvest over the period
2108 covered by the FMP. These acres will be temporarily rendered unsuitable to Northern Spotted Owl,
2109 although the FMP notes that habitat will “recover eventually to at least foraging dispersal but likely to
2110 roosting-foraging habitat...within 30-40 years because of the retention of large structures within all
2111 units” (Higley 2012). Implementation of the FMP and associated projects will result in a decline in total
2112 suitable habitat by approximately 4.4% by the end of the planning period in 2026. Dispersal habitat will
2113 be reduced by approximately 4.9% at the end of 2021 but is expected to rebound to a net reduction of
2114 0.9% by 2026.

2115 The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late
2116 successional reserves to the north, south, and east, and Redwood National Park to the northwest. The
2117 reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40
2118 pairs of owls at all times during the planning period. However, the plan notes this number of Northern
2119 Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009
2120 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl
2121 detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning
2122 in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

2123 Eight forested management units noted in the FMP will retain Northern Spotted Owl dispersal habitat.
2124 None of the forested management units will dip below 50% cover of dispersal or higher quality habitat.
2125 The lowest level of owl habitat retention will occur within the Hopkins management unit, which at 72%
2126 at the time of the publication of the FMP, was projected to drop to 64% in 2012 and increase to 81% by
2127 2026.

Comment [EMG24]: Hoopa is also currently part of the barred owl removal experiment being conducted by USFWS. Hoopa is the treatment area (where barred owls are being removed) and Willow Creek is serving as the control area to compare with Hoopa. Details are provided in the Final EIS for the Removal Experiment (USFWS 2013).

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2128 The FMP includes management actions to mitigate affects to Northern Spotted Owl including land
2129 allocation restrictions, requirements for structural retention within timber sale units and hardwood
2130 management guidelines, and are inclusive of:

- 2131 • The no cut land allocation includes 24,581 acres of which 21,104 acres were forested as of 2011
2132 with stem exclusion or larger size class strata including 10,134 acres of old growth.
- 2133 • 2,819 acres are allocated as reserved for threatened and endangered species. 73 acres are
2134 specifically reserved to protect Northern Spotted Owl nesting core areas.
- 2135 • Seasonal restrictions will apply to all disturbance activities resulting from logging, site
2136 preparation, stand improvement, burning, road construction or reconstruction, and watershed
2137 restoration projects, etc. within 0.25 miles of any known Northern Spotted Owl pair at least until
2138 nesting status is determined from February 1 until July 31. Activities, which modify suitable
2139 nesting/roosting habitat, such as logging, will be further restricted until September 15 of each
2140 year or until the young owls are determined to be capable of moving away from the area or the
2141 reproductive attempt has been determined to have failed. For territories that have been
2142 surveyed continually and found to be unoccupied for 2 or more years, no restrictions shall be
2143 imposed.

2144 *Yurok Indian Reservation*

2145 The Yurok Indian Reservation is located in Del Norte and Humboldt counties inclusive of one-mile on
2146 each side of the Klamath River along a 44-mile stretch. There are approximately 59,000 acres in the
2147 entire Yurok Indian Reservation, and of these, approximately 3,320 acres are forested Tribal trust lands
2148 (i.e., land that the federal government holds legal title to but the beneficial interest remains with the
2149 Tribe), and 2,171 acres are forested allotted lands held in trust (Erler 2012). The remaining lands are fee
2150 lands (i.e., land acquired by the Tribe under legal title outside the boundaries of the Reservation, and in
2151 this case is primarily owned by Green Diamond Resource Company), which are managed intensively for
2152 timber products. Total forested Tribal ownership is 36,637 acres.

2153 The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all
2154 Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for intensive
2155 surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then
2156 dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites.
2157 The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest
2158 reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity
2159 centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl
2160 habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on
2161 disturbance activities within 0.25 mile of Northern Spotted Owl nest.

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2162 *Round Valley Indian Reservation*

2163 The Round Valley Indian Reservation encompasses about 23,200 acres in Mendocino County. More than
2164 two thirds of this area is off-reservation trust land. A total of 2,837 acres are allocated as “Available”
2165 under the Round Valley Indian Reserve FMP (Baldwin, Blomstrom, Wilkinson and Associates 2006),
2166 which means that programmed timber harvest may be allowed. As of 2006, there were eight known
2167 pairs of Northern Spotted Owl either nesting, roosting, or foraging on the Reservation. Approximately
2168 80% of the Reservation could be considered as suitable owl habitat, according to the FMP’s
2169 Environmental Assessment (2006). The FMP would impact about 13% of the 22,150 acres of suitable
2170 habitat on the Reservation. Uneven-aged forest management including single-tree and group selection
2171 is the preferred method, with a 20 year cutting cycle and 100 year rotation, although limited even-aged
2172 management is allowed in specific cases. Harvest is expected to be about 3.4 MFB/acre.

2173 **Nonfederal Land**

2174 *History of Timber Management on Nonfederal Lands and the Forest Practice Rules*

2175 The California Department of Forestry and Fire Protection (CAL FIRE; <http://www.calfire.ca.gov/>)
2176 enforces the laws that regulate logging on privately-owned lands in California. These laws are found in
2177 the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will
2178 also preserve and protect California’s fish, wildlife, forests, and streams. Additional rules enacted by the
2179 State Board of Forestry and Fire Protection (BOF) are found in state regulations and are collectively
2180 referred to as the Forest Practice Rules. The purpose of the Forest Practice Rules is to implement the
2181 provisions of the Forest Practice Act in a manner consistent with other laws, including the California
2182 Environmental Quality Act (CEQA) of 1970, the Timberland Productivity Act of 1982, the Porter Cologne
2183 Water Quality Act, and the California Endangered Species Act (CESA).

2184 CAL FIRE ensures that private landowners abide by these laws when harvesting trees. Although there are
2185 specific exemptions in some cases, compliance with the Forest Practice Act and the Forest Practice Rules
2186 apply to all commercial harvesting operations for private landowners from ownerships composed of
2187 small parcels to large timber companies with thousands of acres.

2188 A Timber Harvesting Plan (THP) is generally the environmental review document submitted by
2189 landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the
2190 steps that will be taken to prevent damage to the environment. THPs are prepared by Registered
2191 Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process
2192 substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber
2193 harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

2194 In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by
2195 the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These
2196 biologists would become the first “designated biologists” who would consult on proposed THPs.

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2197 Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules
2198 and procedures that would be adopted in the event of listing. The rules identified descriptions of
2199 Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for
2200 timber operations to avoid take. The rules called for consultations between plan proponents and
2201 Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to
2202 amend the initially adopted emergency rules; amendments to the rules occurred several times as
2203 knowledge of the Northern Spotted Owl increased and with experience gained through implementation
2204 of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and
2205 919.10 [939.10] in March 1991, which describe options and procedures that can be used in THPs to
2206 avoid take of Northern Spotted Owl or to proceed under incidental take authorization.

2207 Section 919.9 [939.9] includes subsections (a) through (g), which are procedures (referred to as
2208 “options”) among which THP submitters must select and then must follow for THPs within the range of
2209 the Northern Spotted Owl or the “Northern Spotted Owl Evaluation Area” as defined in the Forest
2210 Practice Rules, and for THPs that are situated outside of this Evaluation Area that are within 1.3 miles of
2211 known owl activity centers. The option that is selected must meet on-the-ground circumstances. The
2212 information that each option requires is to be used by CAL FIRE to evaluate whether or not the proposed
2213 timber operations under the THP would result in unauthorized Northern Spotted Owl take. Subsections
2214 (a), (b), (c) and (f) involve CAL FIRE consulting with a Spotted Owl Expert (SOE). An SOE is defined in the
2215 Forest Practice Rules as a person with requisite documented education and experience whose
2216 qualifications have been referred by CAL FIRE to USFWS or the Department for evaluation.

2217 Subsection (a) provides the project proponent the option before a THP is filed of requesting an SOE to
2218 complete a preliminary review of the proposed timber operations to evaluate whether Northern
2219 Spotted Owl take would occur. The SOE must apply the criteria for Northern Spotted Owl take avoidance
2220 specified in Section 919.10 [939.10], and must inform the project proponent whether the proposed
2221 timber operations would or would not cause take. In practice, if an SOE concludes take would be
2222 avoided, the results of such a preliminary review would be included in a THP when submitted to CAL
2223 FIRE for filing, review and approval.

2224 Subsection (b) includes a list of information the project proponent must disclose in a THP; including
2225 functional Northern Spotted Owl habitat within and outside the THP area both before and after harvest,
2226 known owl detections, information on owl surveys conducted and results and other information. It
2227 requires a discussion of how functional Northern Spotted Owl habitat will be protected according to
2228 criteria presented in Section 919.10.

2229 Subsection (c) provides the project proponent the option of obtaining from an RPF a certification to be
2230 included in the THP that Northern Spotted Owls are inferred absent from the THP area and out 1.3 miles
2231 from the THP area based on the results of surveys completed according to the USFWS survey protocol,
2232 (USFWS 2012) and the RPF’s personal knowledge and a review of information in the Northern Spotted
2233 Owl database maintained by the Department.

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2234 Subsection (d) involves the project proponent proceeding under the provisions of an incidental take
2235 permit issued by USFWS or the Department.

2236 Subsection (e) allows the project proponent to proceed with timber harvest according to the outcome of
2237 a consultation with USFWS. This outcome is memorialized in what is referred to as a “technical
2238 assistance letter” from USFWS.

2239 Subsection (f) allows the project proponent to disclose in the THP the outcome of an SOE’s preliminary
2240 review as described under Subsection (a), to demonstrate that any measures to avoid Northern Spotted
2241 Owl take recommended by the SOE have been adopted in the THP and that the proposed timber
2242 operations evaluated by the SOE remain substantially the same in the submitted THP.

2243 Subsection (g) is an option appropriate for THPs where one or more Northern Spotted Owl activity
2244 center has been located within the THP area or within 1.3 miles of its boundary. This option requires the
2245 RPF to determine and document activity center-specific protection measures to be applied under the
2246 THP and that various specified forms and acreages of functional owl habitat (nesting, roosting and
2247 foraging) will be retained post-harvest around each activity center. The minimum acreages to be
2248 retained after harvest of functional nesting, roosting and/or foraging habitat within 500 feet, 500 to
2249 1,000 feet, 0.7 mile and 1.3 miles around each activity center are specified in this subsection.

2250 Section 919.10 [939.10] of the Forest Practice Rules presents the criteria CAL FIRE is to apply to
2251 information provided in the THP and during the THP review period to make a finding as to whether or
2252 not the proposed timber operations will avoid Northern Spotted Owl take in the form of “harass, harm,
2253 pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct”, as
2254 defined under Endangered Species Act (ESA). If CAL FIRE concludes take would occur, they must provide
2255 reasons why the determination was made according to criteria presented in section 919.10 [939.10],
2256 what information was used in making the determination, and recommend minimum changes to the
2257 proposed THP to avoid take. According to Forest Practice Rules Section 898.2, Special Conditions
2258 Requiring Disapproval of Plans, CAL FIRE shall disapprove a THP if the THP would cause Northern
2259 Spotted Owl take prohibited by the ESA.

2260 Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were
2261 provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following
2262 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could
2263 inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol,
2264 breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly
2265 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans
2266 and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol
2267 was revised (USFWS 2012).

2268 When consultations with the USFWS were required, they consisted of a field review of the proposed
2269 THP area, an evaluation of the pre-harvest and predicted post-harvest habitat typing (its suitability for
2270 nesting, roosting, or foraging), the sufficiency of habitat retained post-harvest within 500 feet, 0.7 mile
2271 and 1.3 mile of owl ACs, and an evaluation of the adequacy of the surveys that were conducted (i.e.

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2272 timing, location, interpretation of results) and their consistency with the USFWS protocol. When
2273 appropriate, the Department designated biologists would evaluate or propose THP-specific habitat and
2274 temporal buffers that differed from standard Forest Practice Rules habitat retention and seasonal
2275 restriction requirements that would be adopted as enforceable conditions of THPs.

2276 In 1991, a curriculum was designed to train private consulting biologists who could conduct the field and
2277 document review portions of a Northern Spotted Owl consultation, although final approval from a
2278 Department designated biologist was still required. University biologists and biological consultants,
2279 along with designated Department Timber Harvest Assessment Program staff helped THP submitters to
2280 evaluate their plans with regard to potential take of Northern Spotted Owls. Workshops helped calibrate
2281 consultants, RPFs and others regarding owl life history, habitat associations, and so forth. Northern
2282 Spotted Owl consultations for most THPs were conducted by the Department designated biologists from
2283 1991 into 1997.

2284 From 1991 through 1997 the Department and to a much lesser extent, CAL FIRE staff processed
2285 Northern Spotted Owl consultations for THPs. Additionally, Department staff participated in the review
2286 of private timber company Habitat Conservation Plans, Spotted Owl Management Plans, and Spotted
2287 Owl Resource Plans. In 1994, Department staff was directed to give Northern Spotted Owl consultations
2288 its highest priority and to set aside a minimum number of days per week to address a consultation
2289 backlog. In this same year, CAL FIRE staff was directed to suspend processing of consultations.

2290 In 1995 the Department established a process for certifying “Private Consulting Biologists” (PCBs) to
2291 fully conduct Northern Spotted Owl consultations, which included approval of a consultation package,
2292 and discontinuing the need for additional approval from a Department designated biologist. However,
2293 Department staff continued to process consultations not prepared or reviewed by PCBs.

2294 Beginning in 1999, Department staff no longer processed THP Northern Spotted Owl consultations and
2295 no longer reviewed the work of private consultant biologists. Reasons for the suspension of processing
2296 included:

- 2297 • Other emerging and compelling forestry sector conservation issues required Department staff’s
2298 attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related
2299 workload).
- 2300 • The Department “Timber Harvest Assessment Program” (later to become the “Timberland
2301 Conservation Planning Program”) budget did not include funding specifically for consultations.
- 2302 • Staffing of USFWS offices with wildlife biologists had increased.
- 2303 • The Department felt CAL FIRE and USFWS staff were capable of review, approval, and
2304 assessment of THPs and NTMPs.
- 2305 • The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- 2306 • The scope, quality and conformance of owl-related information with Forest Practice Rules
2307 requirements appeared to have stabilized after approximately six years of implementation.

2308

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2309 Regardless of the suspension in consultation involvement, the Department continued to evaluate THPs
2310 with regard to potential significant impacts to Northern Spotted Owl from timber operations, and as
2311 appropriate reminded THP proponents to comply with Section 3503.5 of the Fish and Game Code. In
2312 addition, the Department continued monitoring compliance with Northern Spotted Owl-related Habitat
2313 Conservation Plan's conservation measures.

2314 At the time that the Department suspended processing of THP and Nonindustrial Timber Management
2315 Plans (NTMP) consultations (1999), the USFWS technical assistance program began. After nine years of
2316 processing technical assistance requests from applicants, the USFWS notified CAL FIRE in 2008 that
2317 technical assistance requests would have to come directly from CAL FIRE rather than the applicant.
2318 Detailed written guidance and information associated with the analysis process was provided to CAL
2319 FIRE, along with scheduled workshops, to assist in the transition from the USFWS to CAL FIRE (USFWS
2320 2008b). The guidance somewhat deviates from the Forest Practice Rules and included information
2321 needed for Northern Spotted Owl technical assistance, descriptions and appropriate uses for the 1- and
2322 2-year owl survey protocols, owl take avoidance scenarios, and the take avoidance analysis process,
2323 habitat retention criteria within 0.5, 0.7 and 1.3 mile radius from the activity center, and a description of
2324 habitat parameters (i.e., nesting/roosting/foraging habitat) for both the interior and coastal regions.
2325 Since this time, CAL FIRE has been responsible for reviewing the majority of Spotted Owl-affected THPs,
2326 and has assisted applicants and USFWS by assessing technical assistance requests if forwarded to
2327 USFWS.

2328 In 2009, the USFWS developed a white paper, Regulatory and Scientific Basis for the U.S. Fish and
2329 Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in
2330 California's Northern Interior Region, to scientifically justify why the 2008 guidance deviated from the
2331 Forest Practice Rules (USFWS 2009). Specific criteria within the USFWS guidelines, and how they differ
2332 from the Forest Practice Rules, are discussed in the Timber Harvest section below.

2333 The Department Timber Harvest Assessment Program was eliminated in late 2010. From a high of 33
2334 staff members state-wide in 2007, fewer than eight remained engaged in forestry environmental review
2335 and permitting in 2011. The remaining positions were assigned to other programs in the Department,
2336 and in some cases were still involved in a range of forestry-sector work (e.g., lake or streambed
2337 alteration agreements, natural community conservation plans, sustained yield plans and limited THP
2338 environmental review).

2339 In 2013, a new Department "Timberland Conservation Planning Program" (TCP) was established through
2340 a stable funding source and authorities mandated pursuant to Assembly Bill 1492 (2012), to ultimately
2341 increase staff to 41 in Department Headquarters and in four Department Regions. Today, TCP Staff
2342 members participate in THP review, process lake or streambed alteration agreements, complete species
2343 consultations (including "pre-consultations") for "sensitive species" and those that are listed or
2344 candidates for listing pursuant to CESA, review forest habitat restoration grant proposal, and other
2345 activities. In addition, as required by Assembly Bill 1492, TCP staff are mandated to and will soon embark
2346 on inspections of approved and completed THPs and compliance and effectiveness monitoring.
2347 Department staff members selectively review Northern Spotted Owl-related information disclosed in

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THPs as part of routine THP environmental review; however, with the broad suite of other mandated THP review-related responsibilities, the TCP's allocated staffing and resources are not adequate to allow staff to engage in Northern Spotted Owl consultations at the level and in ways they did in the 1990s.

Timber Harvest Management

Timber Harvest Plans

As noted previously, a THP is a document that outlines the level and type of proposed timber harvest, and details steps to be taken to prevent damage to the environment, including measures to avoid take of Northern Spotted Owl. Landowners prepare THPs following the provisions of the Forest Practice Rules, and select options for which to follow (Section 919.9 [939.9], subsections (a) through (g)). The purpose of these options is to avoid take of Northern Spotted Owl.

After reviewing all THPs within the Northern Spotted Owl range submitted to CAL FIRE in 2013, it was apparent that Forest Practice Rules section 919.9[939.9], subsections e and g (hereafter referred to as Option (e) and (g)), were the most frequently used among THPs submitted, and thus, have the greatest potential to impact owl habitat. Other THPs applied Section 919.9/939.9, subsections a, b, and d. Therefore, for THPs submitted in 2013 utilizing Option (e) and (g), we assessed each THP, available through CAL FIRE, for consistency and appropriate application regarding impact avoidance to the Northern Spotted Owl.

For the THPs assessed, proposed silvicultural prescription method and acreage was summarized by county. Silvicultural prescription methods are defined in the Forest Practice Rules, and are included in Appendix 1. In addition, for each THP utilizing Option (e) and (g), the potential impact of proposed harvest to activity centers in each option was assessed as well. Due to the different habitat retention guidance for interior and coastal THPs, the assessment conducted for interior counties were conducted only for THPs associated with activity centers within 1.3 miles of the proposed project, and the assessment for coastal counties included only THPs that were associated with activity centers within 0.7 miles.

Within the range of the Northern Spotted Owl in California, a total of 175 THPs were submitted to CAL FIRE in 2013 from ten counties (Del Norte, Humboldt, Mendocino, Shasta, Siskiyou, Sonoma, Napa, Marin, Tehama, and Trinity counties). Of these, 115 THPs were associated with owl activity centers, encompassing approximately 69,226 acres of proposed harvest on private timberland. Figures 12 and 13 summarize number and percent of THPs submitted from each county on the interior and coastal regions. Of the 115 THPs, 93 were coastal THPs associated with owl activity centers within 0.7 mile, and 22 were interior THPs associated with owl activity centers within 1.3 miles.

Of the 115 THPs associated with owl activity centers, a total of 66 utilized Option (e) (60 coastal and six interior), and 9 utilized Option (g) (two coastal and seven interior) in 2013. Silvicultural prescription methods and associated acres of proposed harvest from the 66 THPs that applied Option (e) in 2013 are summarized in Figure 14. Silvicultural prescription methods and associated acres of proposed harvest

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from the nine THPs that applied Option (g) in 2013 are summarized in Figure 15. Variable Retention prescription was the most utilized method for THPs using Option (e), with nearly 28,000 acres of proposed harvest. Alternative, Clear Cut, and Shelterwood prescriptions were the most utilized method for THPs using Option (g), with 1,413, 714, and 657 acres of proposed harvest, respectively. The number of THPs and the cumulative proposed acres for THPs utilizing Option (e) far surpassed those using Option (g).

Proposed silvicultural prescription methods and harvest amounts within the interior and coastal THPs varied significantly. The dominant methods and acreages for 2013 interior and coastal THPs that used Option (e) and Option (g) and are associated with activity centers are summarized in Table 12. In the interior, the Alternative method was proposed more than any other method, covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total acreage. When the Alternative method is used, the plan must include a description of which silvicultural method is most nearly appropriate or feasible, and must also describe how the Alternative method differs from the most similar method. For plans using the Alternative method in the interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the Alternative method used. Alternative method units typically include a habitat retention area, which can range from 2-10% of the harvest unit. Habitat retention areas usually include hardwoods and/or cavity trees to promote use by wildlife species. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more area than all other methods combined.

Table 12. Silvicultural prescription methods proposed within 1.3 miles of an activity center in interior THPs and within 0.7 miles of an activity center in coastal THPs in 2013.

<u>13 THPs from</u>		<u>62 THPs from</u>	
<u>Interior Counties</u>	<u>Acre</u>	<u>Coastal Counties</u>	<u>Acre</u>
Alternative	9,798	Variable Retention	28,144
Group Selection	2,389	Selection	5,227
Clear Cut	2,257	Group Selection	4,314
Shelterwood Removal	1,574	Transition	3,470
Commercial Thinning	1,335	Seed Tree Removal	1,645
No Harvest Areas	1,015	Clear Cut	1,404
		Rehabilitation	990

To better understand the level of impact of proposed harvest and retention to owl activity centers, each THP utilizing Option (e) and Option (g) in 2013 within the interior and coastal region was assessed further. For 13 interior THPs (six using Option (e) and seven using Option (g)), habitat retention and harvest were assessed at two scales: within 0.5 miles and between 0.5 and 1.3 miles of an activity center. For 62 coastal THPs (60 using Option (e) and two using Option (g)), habitat retention and harvest was only assessed within 0.7 miles of an activity center.

It is important to note that the Forest Practice Rules and USFWS guidance regarding habitat retention vary. As mentioned previously, the Forest Practice Rules outline appropriate retention guidelines to be established within THPs submitted under Option (g). In 2009, the USFWS made recommendations for

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2417 habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat
2418 from Forest Practice Rules guidelines.

2419 Forest Practice Rules guidelines under Option (g) are:

- 2420 • Nesting habitat must be retained within 500 feet of the activity center
- 2421 • Roosting habitat must be retained within 500-1000 feet of the activity center
- 2422 • 500 acres of owl habitat must be provided within 0.7 mile radius of the activity center
- 2423 • 1336 acres of owl habitat must be provided within 1.3 mile radius of the activity center

2424 The USFWS (2009) recommendations are:

- 2425 • No timber removal within 1000 feet of activity center, either inside of outside of the breeding
2426 season
- 2427 • At least 250 acres of nesting/roosting habitat and at least 150 acres of foraging habitat must be
2428 retained within 0.5 mile radius of the activity center
- 2429 • Between 0.5-1.3 mile radius of the activity center at least 655 acres of foraging habitat and 280
2430 acres of low quality foraging habitat must be retained

2431 As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern
2432 Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option
2433 (e) in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2434 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center
2435 once timber harvesting had been completed. For each of the six interior THPs, four primary habitat
2436 types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting
2437 as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option
2438 (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a
2439 given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-
2440 habitat.

2441 Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for
2442 THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior,
2443 and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the
2444 interior (2,117 acres within 0.5 miles and 9,776 acres within 0.5-1.3 miles). On the coast, foraging and
2445 nesting/roosting were retained at relatively similar levels within 0.7 miles (52,817 acres of foraging;
2446 47,344 acres of nesting and roosting).

2447 As noted previously, seven interior THPs and two coastal THPs associated with a total of 14 Northern
2448 Spotted Owl activity centers (8 interior activity centers, and 6 coastal activity centers) utilized Option (g)
2449 in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2450 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center
2451 once timber harvesting had been completed. For each of the seven interior THPs, habitat types were
2452 assessed: low quality foraging, foraging, and nesting and roosting. For the two coastal THPs that utilized
2453 Option (g) a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given

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2454 THP. For these two THPs, three primary habitat types were assessed: foraging, nesting/roosting, and
2455 non-habitat.

2456

2457 **Table 13.** Proposed acres of habitat retention near activity centers from THPs utilizing Option (e) in 2013. Totals
2458 include retention acres for 6 interior THPs and 60 coastal THPs (66 THPs total). Owl habitat is defined as low quality
2459 foraging (LQF), foraging (F), nesting/roosting (NR), high quality nesting/roosting (HQNR), and non-habitat (NH).

	<u>6 Interior THPs associated with 14 activity centers, Option (e)</u>		<u>60 Coastal THPs associated with 132 activity centers, Option (e)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	770	4,702	n/a
F	2,117	9,776	52,817
NR	1,487	6,324	47,344
HQNR	1,649	2,940	n/a
NH	n/a	n/a	31,222

2460

2461 Table 14 summarizes proposed acres of owl habitat retention within the interior and coastal regions for
2462 THPs utilizing Option (g). Total acreages presented are cumulative acres for 7 THPs within the interior,
2463 and 2 THPs within the coast. Within the interior, nesting/roosting and foraging habitat were similarly
2464 proposed for retention, with Low Quality Foraging the least common habitat type retained. Within the
2465 coast, nesting/roosting habitats were retained more than either foraging or non-habitat.

2466

2467 **Table 14.** Proposed acres of habitat retention near activity centers from THPs utilizing Option (g) in 2013. Totals
2468 include retention acres for 7 interior THPs and 2 coastal THPs (9 THPs total). Owl habitat is defined as low quality
2469 foraging (LQF), foraging (F), nesting/roosting (NR), and non-habitat (NH).

	<u>7 Interior THPs associated with 8 activity centers, Option (g)</u>		<u>2 Coastal THPs associated with 6 activity centers, Option (g)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	612	3,004	n/a
F	1,032	3,171	1,548
NR	1,388	3,879	2,763
NH	n/a	n/a	1,597

2470

2471 Over time, activity centers may be cumulatively impacted by timber management activities. Through the
2472 use of Option (e) and Option (g), habitat retention and harvest for interior THPs from 2013 were
2473 typically assessed within 0.5 miles and between 0.5 and 1.3 miles of an activity center; whereas for
2474 coastal THPs from 2013 habitat retention and harvest were assessed primarily within 0.7 miles of an
2475 activity center. The 0.5 mile and 0.7 mile radius around activity centers is meant to capture the core
2476 habitat use of Spotted Owls within their home range, whereas the 1.3 mile radius is meant to capture

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2477 the broader home range. Therefore timber harvest within these radii has a potential to impact quality
2478 and extent of owl habitat, and consequently, owl fitness. As discussed previously, to mediate this loss
2479 the Forest Practice Rules set limits on the amount and type of habitat that may be harvested within
2480 certain radii. Since timber growth is slow, and consequently, regrowth of owl habitat is slow, it is
2481 important to understand the cumulative impact to activity centers over time.

2482 To consider the risk of habitat removal to individual activity centers, the amount of habitat proposed for
2483 harvest was calculated for activity centers addressed in THPs utilizing Option (e) and Option (g) over
2484 various periods in time between 1986 and 2013 (Tables 15 and 16). The activity centers evaluated were
2485 selected from those that were associated with THPs submitted in 2013; these activity centers were
2486 evaluated over time by evaluating all THPs associated with these activity centers in past harvest history.
2487 The sample selected for evaluation did not include all of the activity centers associated with THPs in
2488 2013, only a subset. Activity centers were chosen from all counties associated to provide results on a
2489 broad scale. An approximately even number of activity centers were chosen from each county. At the
2490 proposed levels of harvest noted in the THPs, it is apparent that some activity centers have experienced
2491 extensive habitat removal or modification over time. Of the 17 activity centers evaluated in the interior,
2492 six activity centers have experienced greater than 2,000 acres timber harvest cumulatively over time
2493 within the 1.3 mile radius (~3,400 acres) home range, and six activity centers have experienced greater
2494 than 250 acres timber harvest within the 0.5 mile radius (~500 acres) core range. Of the 14 activity
2495 centers evaluated on the coast, six activity centers experienced harvest of over 500 acres, cumulatively,
2496 within the 0.7 mile radius (~985 acres) core range, with two of these over 1,000 acres. Appendix 3
2497 includes bar graphs for each activity center within the coast and interior, and depicts level of harvest
2498 within 0.5, 0.7, and 1.3 mile radii from the activity center.

2499 It is reasonable to assume that high levels of harvest, such as shown for some activity centers in Table 15
2500 and 16, can negatively impact Northern Spotted Owls. Although no study has been conducted
2501 specifically linking the amount of harvest within the 0.5, 0.7, and 1.3 mile radius of an activity center to
2502 impacts on owl fitness (e.g., reproductive rate, survival, etc.), several research studies have
2503 demonstrated a link between owl fitness and amount of habitat, structural characteristics, and spatial
2504 configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007). These studies
2505 are discussed in more depth above in the Habitat Requirements section (Habitat Effects on Survival and
2506 Reproduction) and below in the Habitat Loss and Degradation threat section of this document. Through
2507 comparison of Northern Spotted Owl territory loss on private and federal lands, the USFWS (2009)
2508 suggests that the Forest Practice Rules have not been entirely effective in preventing cumulative loss of
2509 important owl habitat surrounding activity centers associated with repeated harvest. Details regarding
2510 the USFWS analysis can be found in the Regulatory Mechanisms Consideration section of this document.

2511

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Table 15. Proposed timber harvest (in acres) within interior THPs utilizing Option (e) and Option (g) over time (range 1997-2013), showing level of harvest within 0.5 miles and between 0.5-1.3 miles of activity centers. The activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by evaluating all THPs associated with these activity centers since 1997.

Activity Center	Range of Harvest Years	Interior, Option (e) Acres harvested		Interior, Option (g) Acres harvested	
		0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)	0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)
SIS0492	2004-2013	0	915	x	x
SIS0554	1998-2004	102	589	x	x
TEH0030	1998-2013	381	2,554	x	x
TEH0037	1998-2013	379	2,221	x	x
TEH0038	1998-2013	151	1,002	x	x
TEH0072	1998-2013	476	1,954	x	x
TEH0075	1997-2004	277	2,530	x	x
TEH0087	1998-2013	291	2,137	x	x
TEH0101	1997-2013	168	2,113	x	x
TEH0114	2002	0	8	x	x
TEH0117	2006-2013	37	1,123	x	x
SHA0024	2003-2005	x	x	41	239
SHA0037	1998-2013	x	x	0	426
SHA0106	2000-2013	x	x	21	160
SIS0319	1997-2013	x	x	31	1,505
TRI0169	2000-2013	x	x	0	118
TRI0316	1997-2013	x	x	251	495

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Table 16. Proposed timber harvest (in acres) within coastal THPs utilizing Option (e) and Option (g) over time (range 1986-2013), showing level of harvest within 0.7 miles of activity centers. The activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by evaluating all THPs associated with these activity centers since 1986.

Activity Center	Range of Harvest Years	Coast, Option (e) Acres harvested within 0.7 mile radius (~985 acre core area)	Coast, Option (g) Acres harvested within 0.7 mile radius (~985 acre core area)
HUM0058	2011-2013	30	x
HUM0400	1990-2013	510	x
HUM0622	1993-2013	798	x
HUM0791	1999-2013	270	x
HUM0986	1997-2013	162	x
MEN0146	1994-2013	1,180	x
MEN0309	1987-2013	565	x
MEN0370	1992-2010	413	x
HUM0097	1996-2013	x	345
HUM0098	2004-2005	x	67
HUM0308	1996-2013	x	226
HUM0442	2004-2013	x	227
MEN0082	1986-2013	x	1,316
MEN0114	1987-2013	x	829

Nonindustrial Timber Management Plans

In 1989, the Legislature added language to the Forest Practice Act creating provisions to include Nonindustrial Timber Management Plans (NTMPs) to promote long term management and planning on forest ownerships of 2,500 acres or less (Pub. Resources Code §4593 et seq.). Private forestlands are generally classified into non-industrial and industrial ownerships based on acreage and association with industrial uses. Non-industrial private forest (NIPF) owners typically have less than 5,000 acres of forestland and do not own a mill. Of the private forestlands in California, NIPF owners collectively hold about 3.2 million acres (41%), with the balance being held by industrial forest landowners.

The NTMP allows smaller NIPF timberland owners to prepare a long-term management plan that reduces regulatory time and expense by providing an alternative to submitting individual THPs prior to harvest. Landowners agree to manage their forests through uneven-aged management and long-term sustained yield, in exchange for a higher degree of regulatory surety. “Sustained yield” means the yield of commercial wood that an area of commercial timberland can produce continuously at a given intensity of management consistent with required environmental protection and which is professionally planned to achieve over time a balance between growth and removal (Pub. Resources Code, § 4593.2, subd. (d); Forest Practice Rules, § 895.1). Timberland owners operating under an NTMP are also protected under provisions of Public Resources Code section §4593, which offers landowners exemption

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2541 from applying subsequent rule changes to Forest Practice Rules to their project; however, this does not
2542 mean that a NTMP will never be subject to new laws or regulations.

2543 Public Resources Code section §4594 subdivision (h) requires RPFs to submit a Notice of Operations
2544 (NTO) prior to harvest that specifies that the NTMP will implement best management practices for the
2545 protection of water, soil stability, forest productivity, and wildlife, as required by the current rules of the
2546 Board, or is consistent with the original plan and will not result in any significant degradation to the
2547 beneficial uses of water, soil stability, forest productivity or wildlife. Required applications and
2548 administration of NTMPs are detailed in the Forest Practice Rules commencing with section 1090.
2549 Landowners submitting proposed NTO's subsequent to requirements of Forest Practice Rules, section
2550 919.9 [939.9] subdivisions (a) through (g), are expected to either contain specific measures that fulfill
2551 these requirements or best management practices equivalent to such provisions. These options have
2552 resulted in variable and diverse Northern Spotted Owl protection measures within NTMPs; however,
2553 Options (e) and (g) are the most commonly used options. As stated previously, Option (e) allows
2554 landowners to submit a technical assistance letter to the USFWS for approval. Under Option (g), the
2555 landowner must supply the location of activity centers located within the plan boundary or within 1.3
2556 miles of the boundary.

2557 NTMP prevalence has grown steadily since its inception. Table 17 summarizes the approaches
2558 landowners took to protect comply with Forest Practice Rules in avoiding take of Northern Spotted Owl
2559 through NTMPs over time, including numbers of NTMPs within 1.3 miles of an activity center and the
2560 those NTMPs utilizing Option (e) and Option (g) over 1991-2014 for the interior forests, and 2005-2014
2561 for the coastal forests. A total of 157 NTMPs were evaluated within the range of the Northern Spotted
2562 Owl: 35 from the interior portion of the range that were submitted from 1991-2014, and 122 from the
2563 coastal portion of the range that were submitted from 2005-2014. It should be noted that the majority
2564 of NTMPs on the coast were submitted prior to 2005 (418 NTMPs in 1991-2004 versus 122 NTMPs in
2565 2005-2014). However time did not allow full review of that time period for coastal NTMPs. Of the 157
2566 NTMPs evaluated, 115 are within 1.3 miles an owl activity center. Option (e) and Option (g) were applied
2567 in 114 and 14 NTMPs, respectively.

2568 During 1991 through 2014 35 NTMPs have been approved for landowners in the interior portion of the
2569 Northern Spotted Owl range (Siskiyou, Trinity, Shasta, and Tehama counties), with 10 plans utilizing
2570 Option (e), 10 plans utilizing Option (g) and the remainder using another option. Of the 35 NTMPs, 19
2571 (54%) were associated with at least one Northern Spotted Owl activity center within 1.3 miles of the
2572 plan boundary. The coastal portion of the range (Humboldt, Mendocino, Sonoma, Lake, and Napa
2573 counties) saw substantially more NTMPs within a shorter time frame. From 2005 to 2014, 122 NTMPs
2574 were submitted and approved. Although Del Norte County is part of the owl's range, no NTMPs were
2575 submitted during this time frame. Of the 122 NTMPs evaluated, 96 (78%) were associated with at least
2576 one activity center within 1.3 miles of the plan boundary. Of these, the majority (104 NTMPs) utilized
2577 Option (e) (i.e., USFWS technical assistance letter); therefore, the USFWS has been instrumental in
2578 providing consultation and guidance to NTMPs submitters as it relates to protection measures for
2579 Northern Spotted Owl and their habitat.

Comment [A25]: Note to external reviewers:
We are currently working to get all coastal NTMPs (1991-2014) summarized in the table. This will be included in the next version. In addition, number of ACs associated with the NTMPs will be added for all counties.

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2580 **Table 17.** Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years
2581 2005-2014 for plans in Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	NTMPs in NSO Range	NTMPs within 1.3 miles of NSO	NTMPs that implemented 939.9 (e)	NTMPs that implemented 939.9 (g)	NTMPs that used other options
<i>Interior Counties 1991-2014</i>					
Siskiyou	16	13	6	7	1
Trinity	6	3	2	2	0
Shasta	11	3	2	1	0
Tehama	2	0	0	0	2
Interior Subtotal	35	19	10	10	3
<i>Coastal Counties 2005-2014</i>					
Humboldt	41	40	38	2	0
Mendocino	58	45	43	2	0
Sonoma	19	9	19	0	0
Lake	3	1	3	0	0
Napa	1	1	1	0	0
Coastal Subtotal	122	96	104	4	0
Total	157	115	114	14	3

2582

2583

2584 For NTMPs in Siskiyou, Trinity, and Shasta counties measures were analyzed for proposed silvicultural
2585 prescription methods for years 1991-2014, and for years 2005-2014 in Humboldt, Mendocino, Sonoma,
2586 Lake, and Napa counties (Table 18). Only NTMPs that occurred within 1.3 miles of a Northern Spotted
2587 Owl activity center were included in this analysis; therefore, Tehama NTMPs have been excluded.
2588 Silvicultural prescription methods noted in Table 18 are those most often proposed within the NTMPs
2589 analyzed. Other prescriptions proposed but not included in Table 18 include Road Right of Way,
2590 Sanitation Salvage, Special Treatment, Fuel break, and Variable Retention, and is inclusive of 747
2591 cumulative acres.

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2592 **Table 18.** Acres proposed for harvest under NTMPs within 1.3 miles of a Northern Spotted Owl activity center for
2593 various silvicultural prescriptions. NTMPs are from years 1991-2014 for Siskiyou, Trinity, and Shasta counties, and
2594 2005-2014 for Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	Selection	Group Selection	Uneven-aged	Commercial Thinning	Non-Timberland Area	Transition	Rehabilitation of under-stocked
<i>Interior Counties 1991-2014</i>							
Siskiyou	2597	60	1127	251	22	251	251
Trinity	2783	237	653	0	0	0	0
Shasta	1609	1036	2276	273	463	0	0
Interior Subtotal	6989	1333	4056	524	485	251	251
<i>Coastal Counties 2005-2014</i>							
Humboldt	2322	6139	0	35	424	1101	1658
Mendocino	4561	1926	0	0	419	975	71
Sonoma	547	4603	0	0	127	245	246
Lake	45	587	0	0	0	0	0
Napa	0	683	0	0	17	0	0
Napa-Lake	1858	0	0	0	0	0	0
Coastal Subtotal	9333	13938	0	35	987	2321	1975
Total	16322	15271	4056	559	1472	2572	2226

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2595

2596 Of the NTMPs included in this analysis, a total of 42,478 acres were proposed for harvest within 1.3
2597 miles of an activity center. Selection, Group Selection, and Uneven-aged silvicultural methods are the
2598 most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through
2599 the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection,
2600 Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Most plans that
2601 used the Uneven-aged silvicultural method did not delineate acres that would fall under each category.
2602 For NTMPs submitted on the interior from 1991-2014, Selection, Group Selection, and Uneven-aged
2603 totaled 6,989, 1,333, and 4,056 acres, respectively. For NTMP submitted from 2005-2014 on the coast,
2604 Selection and Group Selection totaled 9,333 and 13,938 acres, respectively. Cumulatively, these more
2605 common silvicultural methods equates to 29% (12379/42478) of the total acres proposed for harvest

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2606 under interior NTMPs analyzed, and 55% (23271/42478) of the total acres proposed for harvest under
2607 coastal NTMPs analyzed.

2608 The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl
2609 habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear
2610 that some information was not available to the reviewer due to the nature of the older NTMP
2611 narratives, limited public information, and subsequent amendment submissions. There is simply no
2612 effective way to track this information in an analysis going back in time. Though Selection and Group
2613 Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range,
2614 we can infer that owl habitat is retained to some extent; however, we could not determine the type or
2615 quality of habitat retained. For instance, high quality nesting and roosting habitat may be harvested
2616 more frequently, thereby reducing owl fitness.

2617 Spotted Owl Management Plans

2618
2619 A Spotted Owl Management Plan (SOMP) details measures to avoid take of Northern Spotted Owl as a
2620 result of timber harvest operations on privately owned land. SOMP are developed cooperatively
2621 between USFWS and a private land owner, and can be used to streamline the review of THPs. SOMP
2622 follow the procedures in Forest Practice Rules section 939.9 subdivision (e) and include:

- 2623 • a description of the area covered
2624 • protection measures for breeding or nesting Northern Spotted Owls
2625 • habitat definitions, and
2626 • habitat quality and quantity retention requirements

2627
2628 SOMP are contain expiration dates upon which USFWS and land owners meet to review and revise the
2629 document as necessary; however, incorporation of new scientific information may occur at any time
2630 during the lifetime of the SOMP. SOMP differ from the standard no-take measures provided in the
2631 Forest Practice Rules in that they utilize site-specific information in conjunction with research to develop
2632 strategies to avoid take over a period of years. The most notable difference between SOMP no-take
2633 requirements and those in the standard Forest Practice Rules section is the primarily survey area
2634 required and possibly habitat required post-harvest. Survey areas may be reduced as a result of local
2635 information collected over a number of years. Post-harvest habitat requirements may also be greatly
2636 reduced or increased based on site specific local information.

2637 Three SOMP are currently being used in the THP process in California. Two of these were reviewed for
2638 this assessment by the Department, totaling 175,700 acres in Siskiyou, Trinity and Shasta Counties. The
2639 Department never received a copy of the third SOMP, located in Mendocino County; therefore we are
2640 unable to discuss it here. Both documents reviewed included the elements listed above, and were
2641 developed with the USFWS considering site-specific information for those properties. Within the SOMP
2642 reviewed, suitable habitat definitions were developed specifically for the ownership(s) utilizing the
2643 SOMP. These habitat definitions are developed using information from the property and may be
2644 different from those suitable habitat definitions in survey protocols or other rules or regulations.

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2645 It is not known if the long-term use of SOMP on private lands in California is limiting Northern Spotted
2646 Owl populations, but all operations conducted under a SOMP occur within the known range of Northern
2647 Spotted Owl and usually within suitable owl habitat. More information is needed to fully understand the
2648 effects of SOMP on Northern Spotted Owls.

2649 Spotted Owl Resource Plans

2650

2651 A Spotted Owl Resource Plan (SORP) is intended to offer landowners submitting THPs a programmatic
2652 approach to avoid take of Northern Spotted Owl. SORPs are addressed in Forest Practice Rules section
2653 919.9 subdivision (a), and is defined as, "...an approach to preventing a taking of the northern Spotted
2654 Owl while conducting timber operations [,]" and "...necessarily involves more than one timber harvest
2655 plan." SORPs do not differ significantly from the required habitat retention guidelines found in the
2656 Forest Practice Rules section 919.9 subdivision (g), and mainly provide a programmatic method for
2657 Northern Spotted Owl protection. A description of the area covered, protection measures for breeding
2658 or nesting Northern Spotted Owls, habitat definitions, survey areas and habitat quality and quantity
2659 retention requirements are all provided within a SORP. A SORP may be submitted to CAL FIRE for
2660 preliminary review, and once approved, can be attached to individual THPs submitted by a landowner
2661 under Forest Practice Rules section 919.9 subdivision (a). The THP is reviewed by the Department, but
2662 not necessarily the SORP.

2663 A total of three SORPs have been approved and are being utilized in the THP process in California, and a
2664 fourth SORP is being prepared. The three approved SORPs cover a total of 358,202 acres. All three
2665 SORPs use a combination of no-take language from Forest Practice Rules section 939.9, along with site-
2666 specific information to develop no-take requirements. No specific habitat definitions were developed for
2667 SORPs, and thus, either standard habitat definitions from the Forest Practice Rules or standard habitat
2668 definitions from the USFWS are used within the plans. The site-specific information is used mostly for
2669 protocol survey areas and noise disturbance buffer distances, and is usually developed from historical
2670 survey records and independent noise level studies.

2671 It is not known if the long-term use of SORPs on private lands in California is limiting Northern Spotted
2672 Owl populations, but all operations conducted under a SORP occur within the known range of Northern
2673 Spotted Owl usually are within suitable owl habitat. More information may be needed to fully
2674 understand the effects of SORPs on Northern Spotted Owls.

2675 Habitat Conservation Plans

2676

2677 Under Section 10(a) of the ESA incidental take, defined as take that is incidental to and not the purpose
2678 of the carrying out of an otherwise lawful activity, may be authorized for federally threatened and
2679 endangered species via a Habitat Conservation Plan (HCP). California's Natural Community Conservation
2680 Planning Act of 1991 takes a broader approach than either CESA or ESA. A Natural Community
2681 Conservation Plan (NCCP) identifies and provides for the protection of plants, animals, and their
2682 habitats, while allowing compatible and appropriate economic activity. HCPs and NCCPs are both long-
2683 term landscape level conservation plans that allow harvest of Northern Spotted Owl habitat, which
2684 could result in a specified level of incidental take of owls within the plan area. Generally, these plans

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require historic and occupied Northern Spotted Owl activity centers to be monitored to ensure a healthy and stable population, suitable foraging, and nesting habitat to be maintained or created, and activities to be adjusted accordingly using an adaptive management approach.

Five HCPs that include Northern Spotted Owl as a covered species have been issued in California (Table 19). One plan, on Mendocino Redwood Company land, is in the development process and will be a combination HCP and NCCP. Each of these plans is described in more detail below.

Table 19. Current and planned HCPs/NCCPs in California that include Northern Spotted Owl as a covered species.

Plan Title	Location	Date Permit Issued	Term
Green Diamond Resource Company California Timberlands & Northern Spotted Owl HCP	Humboldt, Del Norte, Trinity Counties	09/17/1992	30 years
Regali Estates HCP	Humboldt County	08/30/1995	20 years
Humboldt Redwood Company HCP	Humboldt County	03/01/1999	50 years
Terra Springs LLC HCP	Napa County	03/03/2004	30 years
Fruit Growers Supply Company HCP	Siskiyou, Shasta, and Trinity Counties	11/27/2012*	50 years
Mendocino Redwood Company HCP/NCCP	Mendocino County	No permits issued	80 years

*A recent court decision in April 2015 determined the Fruit Growers Supply Company HCP to be invalid.

Green Diamond Resource Company Northern Spotted Owl HCP

Green Diamond Resource Company (GDRC) inherited the existing Northern Spotted Owl HCP when they acquired Simpson Timber Company (STC 1992). The HCP has a 30-year term, which expires September 17, 2022, and calls for a full review at the end of 10 years of implementation. GDRC owns approximately 383,100 acres of forestland in California within the Northern Spotted Owl range, mostly within Del Norte and Humboldt counties, with only small portions in Mendocino and Trinity counties, and is located within the California Coast Province. Of the 383,100 acres, 86% are conifer forests comprising two dominant species, coastal redwood, and Douglas-fir. Since most of the conifer forests have been harvested over the last several decades, second-growth makes up all but a small fraction. Residual areas of old-growth forests (logged in the early 1940s and 1960s) make up less than 3%, and are concentrated in the more inland portions of GDRC ownership. Forested areas never logged (virgin old-growth) are scattered throughout the land ownership and consist of 150 acres of redwood and 300 acres of Douglas-fir, comprising less than 2% of GDRC land. Hardwood forests (oak species, madrone, alder) comprise 8%, and non-forest (grassland, wetland, rock and river bars) 6%. As of 1991, just prior to issuance of the HCP, 146 ACs were known to occur on GDRC lands. Density of owls was much higher in the southern portions of land ownership, than the northern portion (1.2 owls/mi² and 0.32 owls/mi², respectively).

During development, the HCP prepared a 30-year age-class forecast model to determine how much habitat would be available to owls over time, and developed a predictive habitat (nesting mosaic) model to estimate nesting habitat on the GDRC land ownership. The age-class forecast covered 1991 through 2021, and assumed timber harvest would occur at an annual rate of 3,000-6,000 acres. Results indicated

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2715 that second-growth stands in the 46+ year age-class would more than double, the 31-45 year age-class
2716 would increase by approximately 50,000 acres in first 10 years then return to 1991 levels, and the 8-30
2717 year age-class would generally decrease over time. The nesting mosaic model was designed to
2718 determine the mosaics of habitat types associated with owl activity centers and utilized the 1991 cover
2719 types and age-classes. Results initially indicated 158,477 acres of GDRC land fit the nesting mosaic
2720 profile, with the number of ACs in 2021 would be roughly the same as the 1991 level.

2721 The level of take (via owl displacement and habitat modification) was estimated at 3 pairs per year over
2722 first 10 years through direct habitat modification (habitat removal within owl sites), and 2 owls per year
2723 over first 10 years via indirect displacement (habitat removal in adjacent stands to owl sites).
2724 Conservation measures were developed to avoid or minimize the likelihood of take, and include:

- 2725 • Habitat management and nest site protection. Implementation will protect nest sites during
2726 breeding and fledging periods, maintain foraging, roosting and nesting habitat, and accelerate
2727 growth of replacement stands. Stands to be harvested March through August will be surveyed
2728 for Spotted Owls before entering area, as well as a 1,000 ft buffer around the area planned for
2729 harvest. Just prior to harvest, up to three more surveys will be conducted. Nest trees will be
2730 marked and no timber harvest is to be conducted within a 0.25 mile radius until after young
2731 have fledged or the nest fails, and a 500 ft radius after fledging until the young disperse.
2732 Valuable land resources for Spotted Owls will be retained on the landscape, such as
2733 hardwood/conifer patches, habitat along watercourses, snags, standing live culls, and brush.
- 2734 • Development of a research program. A research program consists of ongoing owl surveys,
2735 banding owls, monitoring reproductive success, identifying important nest site attributes, and
2736 assessing abundance and distribution.
- 2737 • Development of habitat area to be set-aside. Thirty-nine habitat set-asides were identified in
2738 which timber harvest would not occur. The total acreage of these set asides is 13,242.5 acres
2739 and, as of HCP issuance, 39 owl sites. A 0.25 mile or 500 foot buffers are placed around sites to
2740 ensure timber removal or other associated harvest activities adjacent to set-asides to not impact
2741 owl sites within. Set-asides were monitored annually.
- 2742 • Staff training. A program was developed to properly train GDRC employees and contractors to
2743 monitor owls and collect data.

2744
2745 The trigger for any course correction required during the HCP term will be if the reproductive rate falls
2746 below the rate of the Willow Creek Study Area (WCSA) for three consecutive years. The WCSA was a
2747 good comparison at the time due to its proximity to GDRC and its unique long-term Spotted Owl
2748 dataset. Since 1993, comparisons of reproductive rates at GDRC and WCSA show that the study area
2749 with higher annual reproductive rate often shifts between the two areas. There have not been three
2750 consecutive years with statistically significant results showing the reproductive rate at GDRC falling
2751 below that at WCSA (GDRC 2015).

2752 According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was
2753 happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the

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2754 understanding of suitable owl habitat was limited. In 2006, GDRC submitted an application to the
2755 USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was
2756 issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes
2757 the Project, requires the Applicant to comply with terms of the amended BO and its associated
2758 incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified
2759 the Department that the BO was issued and requested that the Department issue a consistency
2760 determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1.
2761 In January 2014, the Department found that BO, its related ITS and ITP, and the HCP were consistent
2762 with CESA and meet the conditions set forth in Fish and Game Code section 2081 for authorizing
2763 incidental take of CESA-listed species (CDFW 2014a).

2764 The Department found that the mitigation measures identified in the amended ITP and HCP will
2765 minimize and fully mitigate the impacts of take and the continued existence of Northern Spotted Owl
2766 will not be compromised. Measures in the amended versions include, but are not limited to:

- 2767 • Maintaining a 20,310 acres “Special Management Area” in Upper Mad River area where Spotted
2768 Owls may not be taken.
- 2769 • Survey for Spotted Owls in each area where timber harvest is planned, and delay harvest of nest
2770 site and primary activity centers in after the breeding season.
- 2771 • Maintain records of surveys and actual take and notify the USFWS events such as direct harm to
2772 owls, catastrophic events that destroy owl sites, shifts in distribution, accidental death, or injury
2773 of owls, and the finding of dead or injured owls.
- 2774 • Continue gathering data on owl behavior and habitat needs, and update GIS database regularly.
- 2775 • Establish 39 set-asides that represent 13, 252 acres in which timber harvest is not allowed.
- 2776 • Retain, where feasible, resources values that would provide future owl habitat.
- 2777 • Comply, where feasible, with “Overall Resource Management” measures specified in the HCP,
2778 including retention of canopy cover, ground cover, habitat along streams, and a variety of tree
2779 sizes and species within WLPZs.
- 2780 • Implement research on habitat overlap and interactions between Spotted Owls and Barred
2781 Owls.
- 2782 • Conduct surveys according to approved Spotted Owl protocol that accounts for occupancy and
2783 Barred Owl presence, and contact the USFWS for direction as appropriate.
- 2784 • Prepare annual report to record actual instances and number of Spotted Owl sites displaced,
2785 level of habitat loss within owl sites, actual and estimated levels of displacement of past year,
2786 estimated levels of displacement for future year, estimate number of owl sites and amount of
2787 owl habitat, pre- and post-harvest estimates of snags and residual trees in THP areas, results of
2788 nest and set-aside monitoring, and assess efficacy of measures to date.
- 2789 • Provide Department with letter to document financial assurances for HCP implementation.
- 2790

2791 The last annual report (GDRC 2015) described survey results for September 2013 through August 2014
2792 and met the reporting requirements noted above. Since 1992, there has been an overall increase in the

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total amount of Northern Spotted Owl habitat, indicating that growth of forest stands into owl habitat surpassed forested stands impacted by timber harvest. The primary form of incidental take anticipated in the HCP is the displacement of owls due to modification of owl habitat. It was recognized that such displacement could impair essential behavioral patterns and result in actual death or injury to owls. Rather than examining the circumstances of each case to determine whether a take as defined in the ESA had in fact resulted from Green Diamond's habitat modification, the implementation agreement calls for reporting as a "displacement" any instance where an owl site itself is harvested or habitat around an owl site is reduced below thresholds established in the HCP. Each displacement is originally reported on the basis of harvest activity in relation to an owl site within a particular home range; however owls that were recorded as displaced can be removed from the cumulative total if minimum occupancy and nesting criteria are met in the years post-harvest. Based on displacement removal criteria, 33 owls that were recorded as displacements (based on harvest activity) have been removed from the cumulative total (i.e., they are not considered displaced under terms of the HCP). Green Diamond's incidental take permit allows 58 owl pairs to be taken during the 30 year term of the HCP. Although the number of reported displacements per year has been variable, the average is approximately three owl sites per year, leading to 47 owls displaced since 1993 (GDRC 2015).

Regali Estates HCP

This HCP covers 480 acres in Humboldt County, southeast of the town of Ferndale, and is located within the California Coast Province (Regali Estate 1995). Its 20-year term expires August 30, 2015. The plan covered two Northern Spotted Owl activity centers, and contains white-fir, Sitka spruce, redwood, young tree plantations, grassland, and agriculture. The harvest of conifer species resulted in the immediate loss of nesting habitat for one pair. Due to its small size, take afforded by the plan was not deemed to impact regional Spotted Owl populations. Measures set for the plan included: (1) Retention of habitat around nest sites; (2) No harvest impact for a portion of the covered area; (3) Retention of foraging habitat in harvested areas; (4) Salvage of only commercially valuable dead and dying trees; (5) Planting of conifer trees in open grassland habitat; (6) Retention of slash piles for prey habitat; (7) Monitoring of owls; and (8) Completion of biannual reports.

Humboldt Redwood Company HCP

The HRC HCP covers 211,700 acres of coast redwood and Douglas-fir forest in Humboldt County, and is located within the California Coast Province (HRC 2014). Currently the Plan Area contains approximately 208 Northern Spotted Owl activity centers. The term is 50 years, which means the plan will expire March 1, 2049. The primary covered activity is timber management (timber harvest and regeneration, site preparation, planting, vegetation management, thinning, and fire suppression) occurring on approximately 203,000 acres. The HCP requires ongoing monitoring and reporting to ensure that the conservation measures being implemented are accomplishing the desired outcomes. Through the adaptive management process, the monitoring results were used to develop an updated HCP on March 31, 2014.

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- 2830 The overall strategy in the Northern Spotted Owl conservation plan, detailed in the HCP, is to (1)
2831 minimize disturbance to Northern Spotted Owl activity sites, (2) monitor to determine whether these
2832 efforts maintain a high-density and productive population of owls on the ownership, and (3) apply
2833 adaptive management techniques when new information on owl biology/ecology is available and to best
2834 assess the performance of management objectives. Specific habitat retention requirements are
2835 provided to conserve habitat for nesting, roosting, and foraging owls.
- 2836 Northern Spotted Owl management objective outlined in the plan include:
2837
2838 1. Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 2839 2. Maintain Northern Spotted Owl pairs on an average of 80 percent (over a five-year period) of
2840 the minimum 108 activity centers on the ownership. At least 80 of these sites shall be “Level
2841 One” sites, and the balance shall be “Level Two” sites.
- 2842 3. Maintain an average reproductive rate of at least 0.61 fledged young per pair (over a five-year
2843 period) for the minimum of 108 activity centers on the ownership.
- 2844 4. During the first five years of the HCP, maintain and document the minimum number of activity
2845 centers designated in the HCP.
- 2846 Northern Spotted Owl conservation measures outlined in the plan include:
2847
2848 1. Establish a Northern Spotted Owl Scientific Review Panel to review and make recommendations
2849 for monitoring techniques, offer expert review of monitoring results, and make
2850 recommendations on habitat retention standards for maintenance and recruitment of activity
2851 centers.
- 2852 2. Conduct a complete annual censuses (or and approved sampling methodology) to monitor all
2853 activity centers on the ownership and to determine numbers of pairs, nesting pairs, and
2854 reproductive rates.
- 2855 3. If activities are initiated before February 21 and are maintained continuously past the onset of
2856 the breeding season (March 1 through August 31) the THP and a 1,000 foot buffer is to be
2857 surveyed, with timing and number of surveys dependent on when activities are to occur within
2858 the breeding season. For site preparation activities initiated between March 1 and May 31 site
2859 visits will be conducted based on known activity centers within 1,000 feet of activity. Details on
2860 how and when site visits are to occur are site specific. No surveys required if timber operations
2861 occur only outside the breeding season.
- 2862 4. Before June 1 each year, at least 80 activity sites shall be maintained using the habitat retention
2863 guidelines detailed in the HCP, referred to as “Level One” habitat retention. Activity sites
2864 selected for “Level One” retention must have supported owls in the previous year and must also
2865 be active for the year in which the site is selected. If a site is determined to be nesting, no
2866 harvesting shall occur during the breeding season within a 1,000-foot radius of the nest tree.

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- 2867 Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the
2868 activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting
2869 habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable
2870 owl habitat must be provided, if present, and less than 50 percent of this shall be under
2871 operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided,
2872 within 1.3 miles of each activity center.
- 2873 5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of
2874 each year to make up the minimum number of activity centers designated by the HCP. “Level
2875 Two” habitat retention must be active for the year in which the site is selected. If a site is
2876 determined to be nesting, no harvesting shall occur during the breeding season within a 1,000-
2877 foot radius of the nest tree. Following the breeding season, 18 acres around the AC shall be
2878 maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC
2879 must be in place. For sites, which have been determined to be occupied by a non-nesting pair
2880 or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if
2881 present, and a 400 foot radius buffer protecting the activity center must be in place. Harvesting
2882 of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat
2883 retention area.
- 2884 6. Activity center that are not needed to meet management objectives above shall receive “Level
2885 Three” protection measures. These activity centers shall have a 1,000-foot buffer during the
2886 breeding season. Timber harvest associated may occur before March 1 or after August 31.
2887 During the breeding season, for activity centers which have been determined to be occupied by
2888 a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as
2889 suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur
2890 during the breeding season in the area adjoining the 18-acre habitat retention area.
- 2891 7. All nest trees shall be marked and be retained if the activity center is harvested.
- 2892 The HCP outlines an objective to conserve habitat diversity and structural components within the plan
2893 area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types
2894 and seral stages are maintained across the landscape over the permit period, as well as structural
2895 components, to contribute to the maintenance of wildlife species covered under the plan, including the
2896 Northern Spotted Owl.
- 2897 Structural components to be retained include:
- 2898 1. A certain number and size snags that do not pose a human safety hazard.
- 2899 2. A certain number and size of green replacement trees, if snags are not present, with a priority
2900 for trees other than redwood.

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- 2901 3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority
2902 given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or
2903 cavities.
- 2904 4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a
2905 maximum of two per acre.
- 2906 5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given
2907 to logs over 30 inches in diameter.
- 2908 In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that
2909 the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section
2910 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in
2911 fact consistent with CESA and meet the conditions set forth in Fish and Game Code section 2081 for
2912 authorizing incidental take of CESA-listed species (CDFW 2014b).
- 2913 The Department found that the mitigation measures identified in the amended ITP and HCP will
2914 minimize, will fully mitigate the impacts of take and will not compromise the continued existence of
2915 Northern Spotted Owl. Measures in the amended versions include, but are not limited to:
- 2916 • Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and
2917 federal governments to ensure their functions as wildlife reserves in perpetuity.
- 2918 • Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting
2919 habitat in a series of Marbled Murrelet Conservation Areas (MMCAs).
- 2920 • Conduct a combination of night and daytime surveys and stand searches to locate both known,
2921 and any new, owl activity centers.
- 2922 • Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other
2923 conservation elements of the HCP for the retention and recruitment of potential foraging,
2924 roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
- 2925 • Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 2926 • Maintain an average reproductive rate of at least 0.61 fledged young per pair, over a five-year
2927 period, for the minimum of 108 activity centers on the ownership.
- 2928 • Conduct complete annual censuses to monitor all activity centers on the ownership and to
2929 determine numbers of pairs, nesting pairs, and reproductive rates.
- 2930 • Survey the THP area and a 1,000-foot buffer for new operations, except site preparation,
2931 initiated in the period beginning February 21 and ending on or before August 31.
- 2932 • Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and
2933 detection probabilities using accumulated survey data.
- 2934 • Submit annual reports describing the activities undertaken, results of the Operating
2935 Conservation Program, and the proposed Operating Conservation Program activities for the next
2936 year for all lands covered by the HCP.
- 2937

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2938 Annual reports for Northern Spotted Owl have been developed since the HCP's inception. The most
2939 current report (HRC 2015) summarizes the Humboldt Redwood Company's survey effort and whether
2940 management objectives were met. The report states,

2941 "Management objective 1 of the HCP, which requires the maintenance of a minimum of 108
2942 activity sites in the HCP area, was met in 2014 with 136 total occupied activity sites including the
2943 108 core sites. There are currently 215 total activity sites (occupied and unoccupied) on the
2944 property. Management objective 2, which calls for maintenance of Spotted Owl pairs on a five
2945 year running average of 80% at core activity sites, was met in 2014 with a running average of
2946 82%. The pair occupancy rate for 2013 was also 84% (91 of the 108 cores sites were occupied by
2947 a pair of Spotted Owls). Management objective 3 requires the maintenance of a five-year
2948 running average reproductive rate of at least 0.61 fledged young per pair for the core sites (for
2949 those pairs monitored to determine reproductive output). Nesting activity was verified for 33 of
2950 the 91 pairs (of the 108 core sites), and a total of 45 young were fledged, resulting in a
2951 reproductive rate of 0.49 in 2014. The five-year running average of the reproductive rate for the
2952 fifteenth year of the HCP is 0.42, below the requirements of management objective 3."

2953 *Mendocino Redwood Company HCP/NCCP (in planning process; not issued)*

2954 The Mendocino Redwood Company (MRC) is in the process of developing a HCP and NCCP with the
2955 federal and state agencies. Once the permit is issued, the term will be 80 years. The HCP/NCCP will
2956 determine how MRC manages threatened and endangered species, rare plants, and natural
2957 communities on their land ownership in Mendocino and Sonoma counties. The Northern Spotted Owl
2958 will be a covered species in the plan. Approximately 228,800 acres of coast redwood and Douglas-fir
2959 forests exist on MRC land ownership and is located within the California Coast Province. Up to date
2960 progress on the HCP/NCCP development can be found on the MRC website (<http://www.mrc.com>).

2961 *Terra Springs LLC HCP*

2962 The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the
2963 Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa
2964 County west of the city of St. Helena, and is located within the California Coast Province. The plan has a
2965 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year
2966 old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered
2967 lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the
2968 covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded
2969 by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to
2970 maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while
2971 accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting,
2972 roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their
2973 management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees,
2974 felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices,
2975 retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous
2976

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2977 snags, retention of down logs; (3) Timber operations to cease within a 1000 ft buffer of the owl activity
2978 center during the breeding season; (4) Monitor the Spotted Owl site for five years subsequent to the
2979 timberland conversion; and (5) Annual reporting for the first 5 years of the permit.

2980 *Fruit Growers Supply Company HCP*

2981
2982 The Fruit Growers Supply Company (FGS) HCP covers commercial timberland owned and managed by
2983 FGS in Siskiyou County, totaling 152,178 acres (FGS 2012). The Plan Area is within the California Klamath
2984 Province and California Cascades Province. The HCP has a 50 year term that expires November 27, 2062.
2985 In February 2014, FGS notified the Department that the federal BO was issued and requested that the
2986 Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1.
2987 In March 2014, after an amendment to the HCP to fully meet mitigation standards, the Department
2988 found that BO and its related ITS and ITP, and the HCP were consistent with CESA and meet the
2989 conditions set forth in Fish and Game Code section 2081 for authorizing incidental take of CESA-listed
2990 species (CDFW 2014c).

2991 In April 2015, the United States District Court, Northern District of California, found FGS's HCP to be
2992 invalid for the incidental take of two threatened species, the Northern Spotted Owl and the Southern
2993 Oregon/Northern California Coast Coho Salmon. The Order on Cross-Motions for Summary Judgment in
2994 the case *Klamath-Siskiyou Wildlands Center, Center for Biological Diversity, and Klamath Forest Alliance*
2995 *vs. National Oceanic and Atmospheric Administration, National Marine Fisheries, and the United States*
2996 *Fish and Wildlife Service, and Fruit Growers Supply Company* states, "For the reasons explained below,
2997 the Court ... finds the incidental take permits issued by the Services, the biological opinion issued by
2998 NMFS, and the Final Environmental Impact Statement invalid." The HCP amendment to fully meet
2999 mitigation standards was not considered in this case.

3000 Timber management was the primary activity affecting approximately 150,000 acres. FGS land consists
3001 of three management units: Klamath River covering 65,340 acres, Scott Valley covering 39,153 acres,
3002 and Grass Lake covering 47,685 acres. Klamath River and Scott Valley units are dominated by second-
3003 growth mixed evergreen forests that include Douglas-fir, incense-cedar, white fir, ponderosa pine, sugar
3004 pine, canyon live oak, Pacific madrone, California black oak, and Oregon white oak. The Grass Lake unit
3005 contains three major forest types: Sierran Montane Forest and Upper Montane Forest at higher
3006 elevations and Northern Yellow Pine Forest at lower elevations. The Northern Yellow Pine is most
3007 common in the Grass Lake unit, and is dominated by ponderosa pine and white fir. The hardwood
3008 understory species (e.g., oak species and madrone) are largely absent in this unit. Because most of FGS
3009 land has been in commercial timber production since the early 1900s, forests are relatively young (less
3010 than 80 years old) with only small, isolated patches of older stands. Less than 1 percent of the forested
3011 area in the three management units are in WHR size class 5 (> 24 inches dbh) and are considered late-
3012 seral stage. Most of the forested lands (79-93%) are in WHR size classes 3 and 4 (6-24 inches dbh) and
3013 are considered mid-seral.

3014 Covered Activities had the potential to alter forest characteristics, and influence the availability and
3015 quality of habitat for Northern Spotted Owls. Northern Spotted Owl surveys on FGS lands and adjoining

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3016 federal and private lands have shown that many activity centers are located on or have a home range
3017 that extends onto the FGS ownership.

3018 Safe Harbor Agreements

3019
3020 The USFWS states (<http://www.fws.gov/endangered/landowners/safe-harbor-agreements.html>):

3021 “A Safe Harbor Agreement (SHA) is a voluntary agreement involving private or other non-
3022 Federal property owners whose actions contribute to the recovery of species listed as
3023 threatened or endangered under the ESA [see section 10(a)(1)(A)]... In exchange for actions that
3024 contribute to the recovery of listed species on non- Federal lands, participating property owners
3025 receive formal assurances from the Service that if they fulfill the conditions of the SHA, the
3026 Service will not require any additional or different management activities by the participants
3027 without their consent. In addition, at the end of the agreement period, participants may return
3028 the enrolled property to the baseline conditions that existed at the beginning of the SHA.”

3029 There are two SHAs covering Northern Spotted Owl in California, Forster-Gill, Inc., and The Fred M. van
3030 Eck Forest Foundation.

3031
3032 *Forster-Gill, Inc., Safe Harbor Agreement*
3033

3034 The Forster-Gill SHA was issued in June 2002 has a 90-year term, and consists of 236 acres in Humboldt
3035 County one mile north of the town of Blue Lake (USFWS 2002). The majority of the property (91%)
3036 contains young growth coastal redwood (30-35 years old), with 216 acres containing WHR type 4D (12-
3037 24 inch dbh and 60-100 percent canopy closure). At the time of the SHA issuance two owl activity
3038 centers were adjacent to the property, both associated with one pair.

3039 In the SHA, Forster-Gill agrees to enhance and maintain approximately 216 acres of forested Northern
3040 Spotted Owl habitat through timber harvest management designed to create uneven-aged stands with
3041 large tree components, characteristic of high quality owl habitat. Specifically, the SHA will:

- 3042
- 3043 • Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
 - 3044 • Retain all snags not posing a hazard risk.
 - 3045 • Conduct annual owl surveys on property and within a 500 foot radius around the property.
 - 3046 • Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
 - 3047 • Ensure no harvest occurs within 1,000 ft of any active owls nest site.
 - 3048 • Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single
3049 tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and
3050 approved by USFWS.
 - 3051 • Conduct timber stand inventories and provide USFWS with data.
 - 3052 • Allow USFWS or other agreed-upon party access to property for monitoring and management
3053 activities.

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The Fred M. van Eck Forest Foundation Safe Harbor Agreement

The van Eck Foundation SHA was issued in August 2008 has a 90-year term, and covers management activities on 2,163 acres of land in Humboldt County owned by The Fred M. van Eck Forest Foundation (USFWS 2008a). Four management units are identified, of which three (Lindsay Creek, Squaw Creek and Fieldbrook) are located in the Lindsay Creek watershed about one mile of the town of Fieldbrook. The fourth unit, Moonstone, is located in the about ½ mile east of the community of Westhaven. The main forest types found include redwood, Douglas-fir, grand fir, western hemlock, and Sitka spruce. Approximately 80% of the land contains nesting and roosting habitat, with dense canopy cover, and trees over 16 inch dbh. At the time of SHA issuance, no Spotted Owl nesting was documented, however roosting single and pairs were.

The SHA incorporates the terms of the conservation easement granted to Pacific Forest Trust (PFT) in 2001. The conservation easement includes performance goals and restrictions that create forest component recognized as high quality owl habitat.

In the SHA, van Eck Foundation agrees to maintain and protect 6.5 acres of nesting and roosting habitat surrounding an AC, and limit harvesting to single-tree selection or group selection with a target of retaining native species and trees that grow vigorously. Exceptions will be made for trees that have been identified for snag or wildlife tree retention. Canopy cover will remain above 80% (averaged across the stand) upon completion of harvesting activities. Specifically, the SHA will:

- Comply with the conservation strategy, including management performance goals, restrictions on harvest, and road construction and maintenance conditions.
- Retention of all snags not posing a safety hazard.
- Conduct protocol-level surveys and determine reproductive status on property and within 500 foot radius off property, with annual surveys at Lindsay Creek, Squaw Creek, and Fieldbrook units, and one year prior to harvesting activities at Moonstone unit.
- Implement protection measures for up to five activity centers.
- Conduct following protection measures: maintain a 300 foot no-harvest-buffer on up to two activity centers, maintain a 100 foot limited-harvest-buffer on up to three activity centers, no harvest operations to occur within 1,000 feet of any activity center during the breeding season, and no harvest of any known owl nest trees.
- Cooperate with USFWS on Barred Owl control measures.
- Submit timber inventory reports according to management units
- Allow the USFWS or other agreed-upon party, access to property.
- Conduct annual protocol-level surveys and determine reproductive status and success at owl nest sites found for a minimum of three years post-harvest.

Exemption Harvest

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3092 Exemption harvest is meant to assist private landowners wanting/needing to remove trees and may
3093 allow the removal to be exempt from the THP process. The different types of exemptions available
3094 include:

- 3095 • Forest Fire Prevention Exemption
- 3096 • Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption
- 3097 • Less Than Three Acre Conversion Exemption
- 3098 • Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption
- 3099 • Public Agency, Public and Private Utility Right of Way Exemption
- 3100 • Woody Debris and Slash Removal Exemption
- 3101 • Removal of Fire Hazard Tree within 150 feet of a Structure Exemption
- 3102 • Drought Mortality Amendment Exemption 2015
- 3103 • Protection of Habitable Structures Exemption 2015

3104
3105 Any of the above mentioned exemptions may impact Northern Spotted Owls either directly through
3106 habitat removal or indirectly through noise or visual disturbance, depending on the location and on the
3107 yearly timing of operations

3108 Exemption harvest operations must comply with all aspects of the Forest Practice Rules and various
3109 restrictions regarding the operations under the various emergency conditions. In exemption harvest
3110 actions, no known sites of rare, threatened or endangered plants or animals are to be disturbed,
3111 threatened or damaged. However, Northern Spotted Owl protocol-level surveys and habitat
3112 assessments are not generally required by the Forest Practice Rules to operate under an exemption.

3113 Not all exemptions require an RPF certification. Those that do not require the certification are:
3114 Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption, the Public Agency,
3115 Public and Private Utility Right of Way Exemption, Drought Mortality Amendment Exemption and the
3116 Removal of Fire Hazard Trees within 150 feet of a Structure Exemption.

3117 The Christmas Tree/Dead, Dying or Diseased Fuel wood or Split Products Exemption has been available
3118 during the entire time period in which the Northern Spotted Owl has been listed as threatened by the
3119 USFWS. Tree removal is limited to less than 10 percent of the average volume per acre and can be
3120 applied to an entire ownership on any size.

3121 The Forest Fire Prevention Exemption allows the harvest of green merchantable trees, but the logging
3122 area is limited to 300 acres in size and a statement of the postharvest stand stocking level is required as
3123 required in 1038(i) in the Forest Practice Rules.

3124 The Less Than Three Acre Conversion Exemption is applicable to a conversion of timberland to a non-
3125 timber use only, of less than 3 acres in one contiguous ownership, whether or not it is a portion of a
3126 larger land parcel and shall be not part of a THP. Within one month of the completion of timber
3127 operations, including slash disposal, the timberland owner shall submit a work completion report to CAL
3128 FIRE.

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3129 The Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption is not limited to 10% of
3130 the volume per acre and the landowner must notify CAL FIRE of the completion of timber operations
3131 within 30 days of their cessation.

3132 The Public Agency, Public and Private Utility Right of Way Exemption , working with Public Resources
3133 Code section 4628 and Forest Practice Rules section 1104.1(b) exempts public agencies from the
3134 requirement to file an application for timberland conversion or a THP when they construct or maintain
3135 rights of way on their own property or that of another public agency. This exemption extends to
3136 easements over lands owned in fee by private parties. This exemption is not available for rights of way
3137 granted from one private landowner to another.

3138 The Woody Debris and Slash Removal Exemption allows the removal of woody debris and slash that is:
3139 (1) located outside the WLPZ, (2) within the reach of loading equipment operating on existing roads and
3140 landings, (3) developed during timber operations, (4) delivered as combustion fuel for the production on
3141 energy, and (5) in compliance with the conditions of Forest Practice Rules section 1038 subdivision (b)
3142 paragraphs (3),(4),(6),(7),(8) and (10).

3143 The Removal of Fire Hazard Trees within 150 feet of a Structure Exemption allows only trees within 150
3144 feet of an approved and legally permitted structure that complies with the California Building Code
3145 (includes only structures designed for human occupancy, garages, barns, stables and structures used to
3146 enclose fuel tanks) may be harvested under this Notice of Exemption.

3147 The Drought Mortality Exemption was adopted in 2015 by the Board of Forestry due to the prolonged
3148 drought and supercedes the provisions of any other exemption in the same harvest footprint (harvesting
3149 of dead and dying trees). Trees that are dead or trees with fifty percent or more of foliage-bearing
3150 crown that is dead or fading in color are eligible for removal. Under this exemption, it is required to
3151 retain an average for the harvest area of not less than one decadent and deformed tree of value to
3152 wildlife, snag or dying tree per acre that is greater than sixteen inches diameter breast height and
3153 twenty feet tall. This provision does not apply within 100 feet of habitable structures, roads, fire
3154 suppression ridges and infrastructure facilities such as transmission lines and towers or water
3155 conveyance and storage facilities. This exemption requires an RPF signature when timber operations on
3156 a cumulative harvest area exceed twenty acres per total ownership.

3157 The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to
3158 the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet
3159 from any point of an habitable structure that complies with California Building Code for the purpose of
3160 reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily
3161 comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the
3162 treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2,
3163 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project
3164 area shall be increased in the post-harvest stand.

3165 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3166 approximately 41,767,250 acres (1992 to 2013) have been exempted for harvest in counties within the

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range of Northern Spotted Owl (CAL FIRE 2014). These acres do not represent operational acres (actual acres harvested) but only notification acres (possible intended acres harvested). Operational acre reporting is not required; therefore there is no data representing the precise amounts or locations of areas harvested under an exemption. Some of these acres are most likely outside the known range of the Northern Spotted Owl. In addition, some landowners prepare notifications for their entire ownership yearly; yet may only operate on only a small area, thereby possibly compounding this acreage total.

Volume of timber removed under an exemption is reported to the Board of Equalization (BOE), and is another way to assess levels of exemption harvest. With the precise location and yearly timing of the volume reported unknown, specific impact assessments cannot be developed. However, the total volume harvested, average volume amounts by each county and total percentage of harvest volume may be enough to determine that more information is needed. Yearly exemption harvest volume from the counties within the known Northern Spotted Owl range date back to 1990 and average approximately 49,456 MBF (1,000 board-foot) and represent approximately 4.87% of total volume harvested. The highest total amount harvested occurred in 1994 totaling 164,232 MBF, accounting for 15% of the total volume harvested that year. The total exemption volume harvested during the time that Northern Spotted Owl has been listed as threatened by the USFWS is 1,186,954 MBF. The largest amount of exemption volume recorded is from Shasta in 1994 totaling 79,993 MBF, with the largest percentage of total volume coming from Napa (1994), Marin (1996), Glenn (2003), and Lake (2005), where 100% of the total volume harvested was exemption volume (BOE 2014). These volume amounts do not include all volume as the BOE reporting requirements only require volume reporting when \$3000.00 is obtained. The BOE does not track the volume that is less than \$3000.00 in value (A. Tenneson, personal communication, November 18, 2015).

It is not known if the long-term exemption harvesting on private lands in California is limiting Northern Spotted Owl populations, but exemption harvesting may reduce well defined/ critical habitat elements over time. The current exemption harvest process does not require owl habitat analysis or surveys and may directly impact Northern Spotted Owl, and therefore more information is needed to fully assess the impacts from exemption harvest.

Emergency Harvest

Private landowners may cut or remove timber under an emergency basis if “emergency conditions” exist pursuant to Forest Practice Rules section 895.1. Emergency conditions are defined as, “... those conditions that will cause waste or loss of timber resources to the timber owner that may be minimized by immediate harvesting of infected, infested or damaged timber or salvaging down timber; or those conditions that will cause appreciable financial loss to the timber owner that may be minimized by immediate harvesting of timber.”

Types of emergency conditions include:

- Dead or dying trees as a result of insects, disease, parasites, or animal damage.

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3205 • Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood,
3206 landslide, or earthquake.
3207 • Dead or dying trees as a result of air or water pollution.
3208 • Cutting or removing trees required for emergency construction or repair of roads.
3209 • Cutting and removal of hazardous fuels.
3210 • Treatments to eradicate an infestation of Sudden Oak Death.
3211
3212 There is some overlap with types of emergency conditions between Exemption and Emergency harvests.
3213 Exemption Harvest allows only 10% of volume of “dead and dying trees” to be removed, while under an
3214 Emergency Harvest the minimum stocking standards need to be met and does not allow the harvest of
3215 merchantable sawlogs. In addition, Emergency Harvests allow removal of dead trees or trees instituting
3216 an obvious large scale economic loss, whereas Exemption Harvest does not.

3217 Emergency Harvest operations must comply with all aspects of the Forest Practice Rules specific to
3218 emergency operations (Forest Practice Rules § 1052 subd. (a)). Before cutting or removing timber on an
3219 emergency basis, an RPF on behalf of a timber owner or operator must submit a Notice of Emergency
3220 Timber Operations. In Emergency Harvest, no known sites of rare, threatened or endangered plants or
3221 animals are to be disturbed, threatened or damaged. However, Northern Spotted Owl protocol-level
3222 surveys and habitat assessments are not generally required to operate during emergency conditions.

3223 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3224 between 1992 and 2013 approximately 344,542 acres (CAL FIRE 2014) have been notified for emergency
3225 harvest in counties within the owl’s range. These acres may not represent operational acres (actual
3226 acres harvested) but only notification acres (intended acres harvested). Depending on the emergency
3227 condition and stocking requirement, operational acre reporting may not be required; therefore there is
3228 no acreage data or mapping data representing the precise amounts or locations for all emergency
3229 operational areas.

3230 Emergency harvest operations mostly occur in areas where forest stand conditions are dead or fallen,
3231 forest habitat conditions not meeting the definitions of suitable habitat for Northern Spotted Owl under
3232 the Forest Practice Rules, however indirect impacts may occur as a result of the emergency operation.
3233 The emergency notification data is compiled yearly by county, therefore Northern Spotted Owl range-
3234 specific data is not available. Of the total notification acres between 1992 and 2013, some are most
3235 likely outside the known range of the Northern Spotted Owl as the known range line does not include all
3236 of the county area within this acreage data set.

3237 It is not known if the long-term emergency harvesting on private lands in California is limiting Northern
3238 Spotted Owl populations, however, there is some evidence that salvage logging effects use of burned
3239 areas by Spotted Owls. See the discussion of wildfire in the Threats section for additional discussion on
3240 this type of emergency harvest. Some indirect impacts, such as noise disturbance, may be occurring as a
3241 result of emergency operations but level and extent of this potential impact is not well documented.
3242 More information is needed to fully assess the impacts to Northern Spotted Owl from emergency
3243 harvesting.

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Other Management Actions

Forest Certification Programs

Some private landowners in California have voluntarily worked with organizations to achieve certification for their forest landholdings and forestry practices. There are numerous organizations that certify forest products, with Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI) being two of the largest. In order for a landowner to attain certification, they must achieve certain conservation requirements and initiate specific management activities to meet these requirements. For example, a landowner may be required to increase retention in even-aged units, and to achieve this 10-30% of the pre-harvest basal area might be retained in a clumped or dispersed fashion. Another example that could benefit Northern Spotted Owl would be protection of old-growth and legacy trees through the creation of policy and planning documents that ensure their identification and protection (T. Bolton, personal communication, September 5, 2014).

The FSC conducts audits to ensure compliance with FSC certification. In addition, the FSC certification has geographic-specific indicators for the US and Pacific Coast region (FSC 2010a, S. Chinnici, personal communication, September 3, 2014) and has developed a draft framework for assessing “High Conservation Value Forests” (HCVFs) to help land managers identify lands with high conservation value (FSC 2010b). Lands determined to be of high conservation value have extra requirements for monitoring. Conserving these lands enables landowners to get credit for conservation while being able to manage other parts of their land for timber products (FSC 2010a).

The Department does not have an accounting of the number of acres of timberland covered by a forest certification program, nor the quality of the management activities required to meet certification. Therefore, there is not enough information available to suggest what kind of impact, if any, forest certification has had on Northern Spotted Owl populations. However, certification programs may have a positive effect on Northern Spotted Owl in cases where more foraging, nesting, or roosting habitat is maintained than that called for in the Forest Practice Rules.

Conservation Easements

Most of the conservation easements in forested environments within the Northern Spotted Owl range allow for some sort of timber harvest. The Department is involved in only a portion of easement/title projects, and of these projects, the Department is typically not a landowner, title-holder, or manager of these lands. While working with landowners and managers on the easement/title conditions, the Department Lands Program staff suggests conditions conducive to the protection and conservation of wildlife and their habitats.

Due to the variability of landowner needs, the conditions agreed upon for easements constitute a wide range of habitat protection. Thus, it is difficult to draw conclusions as to how easements/titles are contributing to Northern Spotted Owl conservation. Additionally, these areas are not rigorously studied specific to the Northern Spotted Owl.

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State Forests

CAL FIRE operates eight Demonstration State Forests in California, totaling about 71,000 acres. A majority of these forests are actively managed as timberlands and annually produce on average about 30 million board feet of wood. About 53,145 actively-managed acres of State Forest lands occur within the range of the Northern Spotted Owl; this includes Ellen Pickett State Forest (158 acres), Las Posadas State Forest (843 acres), Boggs Mountain Demonstration State Forest (3,425 acres), and Jackson Demonstration State Forest (48,719 acres). State Forests are intended to be used for experimentation and demonstration of various silvicultural methods for their economic and environmental/scientific value. The State Forests have management plans that are periodically reviewed by BOF and all timber harvesting activities on State Forests must comply with the Forest Practice Act and the Forest Practice Rules, including the measures to avoid take of Northern Spotted Owl found in Forest Practice Rules sections 919.9 and 919.10.

Jackson Demonstration State Forest (JDSF) is the largest of the eight forests (49,000 acres) and represents nearly 70% of the total State Forest acreage in California. This forest has been managed and harvested since 1862 and was acquired by the State in 1947. Located in central Mendocino County, the forest consists primarily of coast redwood and Douglas-fir, with some old-growth coast redwood remaining. Forest stands on JDSF have been managed on an even-aged and uneven-aged basis under various silvicultural systems; however, special restrictions are put on even-aged management and clear-cutting (CDF 2008, CDF 2014).

The JDSF Management Plan (CDF 2008) contains a Northern Spotted Owl Conservation Strategy, with the goal to “maintain or increase the number and productivity of nesting owl pairs through forest management practices that enhance nesting and roosting opportunities and availability of a suitable prey base.” CAL FIRE monitors certain Northern Spotted Owl activity centers on JDSF and the Management Plan conditions are nearly identical to the Forest Practice Rules.

State Parks

The California Department of Parks and Recreation (CA State Parks) manages 280 park units in California; 64 of these park units are within the range of the Northern Spotted Owl, totaling 214,286 acres. CA State Parks’ mission, in addition to preserving biodiversity, includes protecting cultural resources and creating recreation opportunities. CA State Parks does not have a management plan for the Northern Spotted Owl and management for species occurs at the park unit scale. Each park unit prepares a general plan that describes the range of activities occurring within the park unit and resource protection that the park unit enables.

The largest State Park (SP) in the Northern Spotted Owl range, Redwood National and State Parks, is jointly managed by the NPS and CA State Parks and includes: Redwood National Park, Jedediah Smith Redwoods SP, Del Norte Coast Redwoods SP, and Prairie Creek Redwoods SP. RNSP does not have specific Northern Spotted Owl management actions in its General Management Plan/General Plan, but does have vegetation management actions for old-growth, second-growth, prairie and fires. Old-growth forests are protected, managed, and restored to provide habitat for species and to reduce fire hazards.

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3323 Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to
3324 reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak
3325 woodlands and prairies is managed through tree removal and burning. Nine management zones within
3326 the RNSP delineate the degree of human influence and development on that can occur on the landscape
3327 (NPS 2000a).

3328 Similar to Redwood National and State Parks, the second largest park unit within the Northern Spotted
3329 Owl range, Humboldt Redwoods State Park, does not engage in specific management activities for
3330 Northern Spotted Owl, but protects and manages for old-growth stands to be sustained over time (CDPR
3331 2001).

3332 California State Parks do not engage in regular surveys for Northern Spotted Owl within State Parks,
3333 though surveys sometimes occur before park projects are started. However, adjacent timberland
3334 owners routinely survey Northern Spotted Owl activity centers within State Parks (T. Fuller, personal
3335 communications, September 2, 2014).

3336 *University of California Natural Reserves*

3337
3338 Comprised of more than 756,000 acres across 39 sites and representing most major California
3339 ecosystems, the UC Natural Reserve System (UCNRS) is the largest university-administered reserve
3340 system in the world. By supporting university-level teaching, research, and public service, the UCNRS
3341 contributes to the understanding of and wise stewardship of California's natural resources. Five UCNRS
3342 sites (totaling 4,625 acres) across California occur within the range of the Northern Spotted Owl, though
3343 there are no management plans or Northern Spotted Owl SO data for individual reserves (UC 2014).
3344 Angelo Coast Range Reserve has had three Northern Spotted Owl territories through since the late-
3345 1980s, but since Barred Owls were detected in the area starting in 1999 Spotted Owls have not been
3346 detected at any of the three sites (A. Franklin, personal communication, March 23, 2015).

3347 *Department Ecological Reserves*

3348
3349 Authorized by the California Legislature in 1968 and administered by the Department, the ecological
3350 reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats,
3351 and to provide areas for education and scientific research. The system now encompasses 119 properties
3352 totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur
3353 within the range of the Northern Spotted Owl; however there are no management plans for the system
3354 or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception
3355 is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by
3356 BLM, which manages for late seral habitat benefiting Spotted Owls.

3357 *Fisheries Restoration Grant Program*

3358 As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern
3359 Spotted Owls and their habitat are required for each project funded. The purpose of FGRP is to support
3360 restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must

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provide a detailed proposal that thoroughly addresses all criteria of the FGRP, one of which is avoidance and minimization measures for Northern Spotted Owls if a project proposes to conduct work in owl habitat. The geographic area covered by FGRP almost completely overlaps with the Northern Spotted Owl range in California, therefore the potential for a project be in owl habitat is high. Once a project is approved, the proponent must obtain a Lake or Streambed Alteration Agreement (LSAA) from the Department to comply with the CEQA. The LSAA will include conditions for the protection of wildlife and habitat, and must be followed during project activities.

To avoid potential impacts to Northern Spotted Owls FRGP projects must adhere to the following, as noted in the LSAA:

- Work with heavy equipment at any site within 0.25 miles of suitable habitat for the Northern Spotted Owl shall not occur from November 1 to July 9.
- The work window at individual work sites may be advanced prior to July 31, if protocol surveys determine that suitable habitat is unoccupied.
- If these mitigation measures cannot be implemented or the project actions proposed at a specific work site cannot be modified to prevent or avoid potential impacts to Northern Spotted Owls or their habitat, then activity at that work site will be discontinued and the project proponent must obtain incidental take authorization from the USFWS.
- For projects contained within streams and watersheds included in a USFWS Habitat Conservation Plan the mitigation measures contained within those Habitat Conservation Plans shall be followed.

The grant program is very successful and funds numerous projects each year. In fiscal year 2013/2014 alone, FRGP funded approximately \$16.5 million dollars in 56 projects, of which 44 projects were located within the range of the Northern Spotted Owl.

Threats (Factors Affecting Ability to Survive and Reproduce)

Historical Habitat Loss and Degradation

Historical Habitat Loss

Historical (pre-logging) variability in forest age and structure in the range of the Northern Spotted Owl was controlled by natural processes, including wildfires (Courtney et al. 2004). Estimates of pre-logging extent of old forest in western Washington and Oregon are relatively consistent and range from 60 to 72% of the landscape (Courtney et al. 2004). When the USFWS listed the Northern Spotted Owl as threatened in 1990, estimates of historical Spotted Owl habitat loss ranged from 60 to 88% loss rangewide since the early 1800s (USFWS 2011a). Much of this loss was attributed to timber harvest and to land-conversion, and was concentrated mostly at lower elevations and in the Coast Ranges (USFWS 2011a). This pattern of historical loss is apparent in the current distribution of suitable habitat, with

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3396 large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat
3397 (see Figure 4).

3398 Prior to 1990, the annual rate of removal of Spotted Owl habitat on national forests as a result of logging
3399 had been about 1% per year in California and 1.5% per year in Oregon and Washington (USFWS 1990,
3400 2011). At the time, it was projected that future rates of habitat removal would eliminate all nesting and
3401 roosting habitat on non-protected BLM lands in Oregon, with the exception of the Medford District, by
3402 the year 2016 (USFWS 1990). Estimates from the decades before 1990 indicate that harvest rates on
3403 private industrial lands were consistently about twice the average rate of harvest on public land (Cohen
3404 et al. 2002). Regarding harvest rates on private industrial and non-industrial lands, Bigley and Franklin
3405 (2004) estimated harvest rates in the late 1980s and early 1990s for private industrial land of 2.4% per
3406 year, and harvest rates on non-industrial lands increased from 0.2% in the 1970s to a rate similar to that
3407 of the private industrial lands by the early 1990s.

3408 *Assessing Habitat Loss through Implementation of the Northwest Forest Plan*

3409 | The Northern Spotted Owl was listed as threatened under the federal Endangered Species Act in 1990 in
3410 part because of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS
3411 1990). The revised recovery plan lists the most important threats to the Spotted Owl as competition
3412 with Barred Owls, ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or
3413 degradation from stand replacing wildfire and other disturbances, and loss of amount and distribution of
3414 Spotted Owl habitat as a result of past activities and disturbances (USFWS 2011a). To address ongoing
3415 decline of Northern Spotted Owl habitat across the range, the NWFP established reserved lands
3416 including late-seral reserves, adaptive management reserves, congressionally reserved lands, managed
3417 late-successional areas, and larger blocks of administratively withdrawn lands (USDA and USDI 1994)
3418 (Figure 11). These are described in more detail above. It was assumed that habitat in reserves would
3419 improve over time as successional processes led to more mature forests, however, this is a slow process
3420 and so recruitment of habitat conditions on reserves was expected to take many decades. It was also
3421 assumed that habitat outside of reserves would continue to decline due to timber harvest and other
3422 disturbances but that dispersal habitat would be maintained in order to facilitate movement between
3423 reserve lands. Given the continued Northern Spotted Owl population declines and the increasing threat
3424 of the Barred Owl, the revised recovery plan recommended conserving occupied sites and unoccupied,
3425 high-value Spotted Owl habitat on state and private lands wherever possible (USFWS 2011a).

3426 In order to understand the degree to which the NWFP contributes to conservation of owl habitat, the
3427 rangewide trends in habitat are regularly assessed. To date, assessments have been performed at the
3428 10-year and 15-year time points (Davis and Lint 2005, Davis et al. 2011). The recent assessment
3429 estimated rangewide habitat changes on federal and nonfederal lands from 1994 through 2007 for
3430 California and from 1996 through 2006 in Oregon and Washington by comparing vegetation maps for
3431 two bookend time periods. In addition to rangewide changes, trends for each physiographic province
3432 and for each state are also reported (Davis et al. 2011). The assessment tracks changes in Northern
3433 Spotted Owl nesting and roosting habitat, and also tracks changes in dispersal habitat within and

Comment [EMG26]: The 20-year report should be available soon. I don't see the full report on the REO website yet, but there is some summary info from presentations made this summer.

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3434 between the reserves. Foraging habitat is not assessed through modeling for the NWFP. Nesting and
3435 roosting habitat maps were produced through habitat suitability modeling using several forest structure
3436 variables (e.g., percent conifer cover, average conifer dbh, average stand height) and a forest age
3437 variable (Davis et al. 2011). Vegetation stands were placed in one of four categories (highly suitable,
3438 suitable, marginal, and unsuitable), with highly suitable and suitable categories assumed to represent
3439 nesting and roosting habitat (Davis et al. 2011). To assess change, an area was considered to have lost
3440 nesting and roosting habitat if its condition moved from suitable or highly suitable to marginal or
3441 unsuitable.

3442 Although federal lands contain less than half of the total forest land within the entire range of the
3443 Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and
3444 roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and
3445 roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands
3446 lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal
3447 lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance
3448 (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost
3449 on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the
3450 fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl
3451 range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands
3452 has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only
3453 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on
3454 nonreserved lands.

3455 Conversely, on nonfederal lands most of the nesting and roosting habitat loss was due to harvest (about
3456 625,600 acres; 14.9%). On nonfederal lands in Oregon and Washington, the extent of older forest
3457 harvested annually declined following implementation of the NWFP. However, this decline was likely
3458 due to exhaustion of the available inventory, as the annual harvest rate stayed relatively steady when
3459 measured as a percentage of the remaining older forest (Healey et al. 2008). A relatively small amount
3460 of nesting and roosting habitat on nonfederal lands was lost to fire, insects, and disease (0.6%; about
3461 23,700 acres).

3462 Relative rates of nesting and roosting habitat loss on federal vs. nonfederal lands in California follow the
3463 rangewide pattern. Consistent with the entire subspecies range, loss of nesting and roosting habitat on
3464 federal lands in California was mostly due to wildfire and other natural disturbances (4.2%; 77,500
3465 acres), with a higher rate of loss than on federal lands rangewide (2.8%) (Davis et al. 2011). Most of the
3466 loss to natural disturbance in California occurred in the Klamath Province (73,200 acres), with almost all
3467 of the loss due to wildfire (Davis et al. 2011). Harvest rate of nesting and roosting habitat on federal
3468 lands in California was fairly low and matched that of federal lands rangewide (0.6%; 11,200 acres),
3469 although 3.0% of the nesting and roosting habitat on federal lands in the California Cascades Province
3470 was harvested (6,500 acres), which was the highest rate of harvest on federal lands across all provinces
3471 rangewide (Davis et al. 2011).

Comment [EMG27]: Over what time period?

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3472 As with the rangewide pattern, nonfederal lands in California experienced much greater loss of nesting
3473 and roosting habitat to harvest than to natural disturbance. The acreage of nesting and roosting habitat
3474 harvested on non-federal lands in California was about 90,200 acres (5.8%), which exceeds the total
3475 amount of habitat loss on federal lands in California (Davis et al. 2011). This is consistent with the
3476 rangewide pattern showing that the bulk of total nesting and roosting habitat loss has been due to
3477 harvest on nonfederal lands; although the majority occurred in Washington and Oregon, more nesting
3478 and roosting habitat was lost to harvest on non-federal lands (about 625,600 acres) rangewide than
3479 total loss on federal lands from harvest and natural disturbance combined (about 298,600 acres total)
3480 (Davis et al. 2011). California has more nesting and roosting habitat on nonfederal lands than either
3481 Washington or Oregon but has lost relatively less due to harvest, with Washington and Oregon losing
3482 18.6% and 21.8%, respectively, compared to 5.8% in California (Davis et al. 2011). This is likely due to
3483 differences in habitat retention requirements in the regulations of each state. On nonfederal lands in
3484 California, nesting and roosting habitat loss to natural disturbance was relatively low at 0.4% (about
3485 7,500 acres) (Davis et al. 2011).

3486 Davis et al. (2011) estimated amount of dispersal habitat across the range of the Northern Spotted Owl
3487 at the start of the NWFP and at the end of the study period (2006 or 2007 depending on location) by
3488 querying GIS vegetation databases for forests with conifer dbh ≥ 11 inches and conifer cover $\geq 40\%$ (see
3489 Figure 5). This is similar to the definition of minimum dispersal habitat from Thomas et al. (1990).
3490 Modeled nesting and roosting habitat was also included in the mapped dispersal habitat because owls
3491 will disperse through forests meeting the requirements of nesting and roosting habitat. Trends in
3492 dispersal habitat over the study period were analyzed within and between federal reserved lands. The
3493 distribution of “dispersal-capable” habitat was also mapped by combining results of the mapped
3494 dispersal habitat with estimates of maximum dispersal distance from Forsman et al. (2002) (Figure 17).
3495 This estimate of dispersal-capable habitat on the landscape allowed for a measure of the ability of owls
3496 to disperse between habitat reserves, which is a goal of the NWFP and an important functional measure
3497 of habitat beyond a simple acreage estimate of total dispersal habitat.

3498 Increases in dispersal habitat, as defined by conifer forests exceeding 11 inches dbh and 40% canopy
3499 cover, occurred through forest succession and through partial disturbance of nesting and roosting
3500 habitat to smaller, more open forest. Recruitment of dispersal habitat exceeded loss rate for a net
3501 increase of 5.2% rangewide (Davis et al. 2011). However, given the distribution of habitat increases and
3502 losses, the dispersal-capable habitat on the landscape decreased by about 1% (Davis et al. 2011); on
3503 federal lands this loss was largely due to wildfire (Figure 18). Losses of dispersal-capable habitat
3504 occurred mostly around the periphery of federal forests; Davis et al. (2011) suspect this is due to timber
3505 harvesting on nonfederal lands that border federal lands. Gains in dispersal-capable habitat also often
3506 occurred at the periphery of federal forests, as forest succession in younger or recently harvested
3507 forests led to forests meeting the minimum dispersal requirements.

3508 The network of large federal reserves across the range of the Northern Spotted Owl is fairly well
3509 connected, although there are exceptions in the Olympic Peninsula, the eastern Washington Cascades,
3510 and in the southern end of the range in California. The Marin County population is poorly connected to

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other federal reserves, and large portions of the California Coast physiographic province are mapped as having poor dispersal-capability. However, the definition of minimum dispersal habitat in Thomas et al. (1990) and used to map trends in the NWFP may not capture the full range of dispersal habitat conditions in Northern California, where Northern Spotted Owls use younger forests (USFWS 2011a).

Timber Harvest

Timber Harvest on Private Land

The Northern Spotted Owl was federally listed as ~~Threatened~~threatened in 1990 larger due to extensive habitat loss from timber harvest activities on federal and nonfederal land. In 1991, the California Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] were enacted, which describe options and procedures that can be used in THPs to avoid take of Northern Spotted Owl or to proceed under incidental take authorization. Compliance with the Forest Practice Rules apply to all commercial timber harvesting operations for private landowners (excluding specific exemptions discussed in the Timber Harvest Management section of this report) from small parcels operations to large timber operations. Forest Practice Rules 919.9[939.9] specify subsections (a) through (g), which give the landowner options among which to select and follow for timber harvest within the range of the Northern Spotted Owl.

THPs are plans submitted by the landowners that serve as the environmental review document and they outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment, including impacts to Northern Spotted Owl activity centers. NTMPs are plans meant to promote the long term management and planning on forest ownerships of 2,500 acres or less, and they allow an alternate to submitting individual THPs prior to harvest. Landowners with approved NTMPs agree to manage their forests through uneven-aged management and long-term sustained yield.

As detailed in the Timber Harvest Management section of this report, the Department evaluated a subset of THPs and NTMPs submitted that fell within the range of the Northern Spotted Owl. Evaluation effort for each plan type varied depending on time constraints and level of information that was readily available, and included a summary of number of THPs submitted, types of silvicultural methods most used, and acres of habitat proposed for harvest and retention. For THPs, all plans submitted in 2013 were evaluated, and a subset of Northern Spotted Owl activity centers from plans utilizing Option (e) and (g) (the most commonly used options from Forest Practice Rules 919.9[939.9]) were followed back in time to summarize cumulative harvest activities impacting the owl sites. For NTMPs, plans submitted within interior counties from 1991-2014 were evaluated, and plans submitted within coastal counties from 2005-2014 were evaluated.

Within the interior THPs evaluated, the Alternative method was proposed more than any other method, covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total acreage. An Alternative silvicultural prescription can be included in a timber harvest plan when an alternative regeneration method or intermediate treatment is more effective or more feasible than any of the standard silvicultural methods (see Appendix 1). For plans using the Alternative method in the

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interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the Alternative method used. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more area than all other methods combined. Forest Practice Rules Section 913.4(d) defines Variable Retention as an approach to harvesting based on the retention of structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for integration into the post-harvest stand to achieve various ecological, social and geomorphic objectives (see Appendix 1).

Of the NTMPs evaluated, Selection, Group Selection, and Uneven-aged silvicultural methods are the most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection, Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Uneven-aged management means the management of a specific forest, with the goal of establishing a well-stocked stand of various age classes which permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop (see Appendix 1). Most NTMPs evaluated that used the Uneven-aged silvicultural method did not delineate acres that would fall under each category, therefore there is limited ability to assess the type of harvest applied on the landscape. Under the Selection and Group Selection methods, the trees are removed individually or in small groups sized within areas of 0.25 to 2.5 acres.

Types of silvicultural practices vary on the landscape and may impact Northern Spotted Owls differently depending on a variety of factors surrounding type and extent of habitat removed. For example Clear Cut harvesting (removal of an entire stand in one harvest), depending on how it is applied on the landscape, has a potential to negatively impact Northern Spotted Owls. Impacts from harvest have been recognized in the literature since the time the owl was federally listed (UFWs 2011a). Yet implementation of other frequently used silvicultural methods (e.g., Alternative, Variable Retention, Group Selection, Uneven-aged) have less obvious impacts to Northern Spotted Owl foraging, nesting, and roosting habitat. Some harvest methods may serve to reduce habitat quality by removing key components of owl habitat near Northern Spotted Owls activity centers. For example, thinning has been shown to decrease the abundance of Northern Flying Squirrels and Red Tree Voles, two important prey species for Northern Spotted Owls (Wilson and Forsman 2013). Alternatively, applied at appropriate scales, some methods may in fact serve to enhance owl habitat, for example, by increasing foraging opportunities. Given the potential of both negative and positive impacts to the Northern Spotted Owl, more thorough documentation and rigorous evaluation of harvest type and actual harvest levels of foraging, nesting, and roosting habitat, within harvest plans are needed. In addition, research is needed to provide a clearer understanding of the effects of silvicultural practices on important prey species habitat.

To evaluate the level of impact of proposed harvest and retention to Northern Spotted Owl activity centers, each interior and coastal THP utilizing Option (e) and Option (g) in 2013 within the region was assessed further. Retention and harvest were assessed at two scales for interior THPs: within 0.5 miles and between 0.5 and 1.3 miles of an activity center. For coastal THPs, retention and harvest was only assessed within 0.7 miles of an activity center. For THPs utilizing Option (e), foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within

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3588 0.5-1.3 miles). On the coast, foraging and nesting/roosting were retained at relatively similar levels
3589 within 0.7 miles (52,817 acres of foraging and 47,344 acres of nesting and roosting). For interior THPs
3590 utilizing Option (g) nesting/roosting (1,388 acres within 0.5 miles and 3,879 acres within 0.5-1.3 miles)
3591 and foraging habitat (1,032 acres within 0.5 miles and 3,171 acres within 0.5-1.3 miles) were similarly
3592 proposed for retention, and within the coast, more nesting/roosting habitat was retained (2,763 within
3593 0.7 miles).

3594 Timber harvest within the 0.5, 0.7 and 1.3 radii (representing different levels of habitat use by Northern
3595 Spotted Owls) has a potential to impact quality and extent of owl habitat, and consequently, owl fitness.
3596 Timber growth is slow, and consequently, regrowth of owl habitat is slow. Therefore, it is important to
3597 understand the cumulative impact to activity centers over time. As a way of evaluating this impact, the
3598 amount of habitat proposed for harvest was calculated for activity centers that were associated with
3599 THPs utilizing Option (e) and Option (g) submitted in 2013 were selected, and harvest history followed
3600 back in time. Of the 17 activity centers evaluated in the interior, six activity centers have experienced
3601 greater than 2,000 acres timber harvest cumulatively over time within the 1.3 mile radius (~3,400 acres)
3602 home range, and six activity centers have experienced greater than 250 acres timber harvest within the
3603 0.5 mile radius (~500 acres) core range. Of the 14 activity centers evaluated on the coast, six activity
3604 centers experienced harvest of over 500 acres, cumulatively, within the 0.7 mile radius (~985 acres) core
3605 range, with two of these over 1,000 acres (see Table 15, Table 16 and Appendix 3).

3606 Of the interior NTMPs evaluated, 19 (54%) were associated with at least one Northern Spotted Owl
3607 activity center within 1.3 miles of the plan boundary. Of the coastal NTMPs evaluated, 96 (78%) were
3608 associated with at least one activity center within 1.3 miles of the plan boundary. For NTMPs, it was
3609 difficult to assess the extent of harvest and habitat retention because the level of information available,
3610 particularly older plans, was limited in some cases. Considering NTMPs evaluated, we can infer that owl
3611 habitat is retained to some extent; however, we cannot determine the type or quality of habitat
3612 retained. For instance, high quality nesting and roosting habitat may be harvested more frequently,
3613 thereby reducing owl fitness.

3614 Several research studies have demonstrated a link between owl fitness and amount of habitat,
3615 structural characteristics, and spatial configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al.
3616 2005, Irwin et al. 2007) – see the Habitat Effects on Survival and Reproduction and the Habitat Loss and
3617 Degradation sections of this document. Given what we know about owl habitat and fitness, it is
3618 reasonable to believe that high levels of harvest, such as levels documented for some activity centers in
3619 the harvest analysis described above, can negatively impact Northern Spotted Owls. In some of the
3620 activity centers evaluated for harvest history, harvest cumulatively exceeded the guidance provided in
3621 the Forest Practice Rules regarding the amount of habitat retention. Furthermore, by comparing
3622 territory loss on private timber lands to USFS lands from 1978-2007 the USFWS (2009) found a 54%
3623 decline in pair status to no response and a 23% decline from pair status to single owl status on private
3624 timber lands, whereas on USFS lands 80% of the sites did not change pair status. These results suggest
3625 inefficiency in rules guiding timber harvest for the protection of Northern Spotted Owls.

Comment [EMG28]: Or would this be
"insufficiency" ?

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3626 *Harvest of Hardwood Forests*

3627 The economic value of tree species growing on timberlands differs, with conifers being generally more
3628 valuable than hardwoods. The low value of hardwoods historically discouraged their harvest and
3629 removal from timberlands during commercial harvesting (Merenlender et al 1996). The differential
3630 retention of hardwoods coupled with aggressive growth of tanoak during early successional processes
3631 lead many north coast timberlands to be heavily dominated by hardwoods.

3632 To counter this history, the Forest Practice Rules (CCR 912.7, 932.7, and 952.7) provide timber resource
3633 conservation standards that require that the percentage of site occupancy of Group A (generally
3634 conifers) species to not be reduced relative to Group B species (generally hardwoods) as a result of
3635 harvest. The Forest Practice Rules specifically require retention of trees of each native commercial
3636 species inclusive of Group B hardwoods where present at the time of harvest in a limited number of
3637 silvicultural situations: during the seed step of shelterwood (913.1, 933.1, 953.1 (d)(2)(F)) and seed tree
3638 (913.1, 933.1, 953.1 (c)(1)(F)) silvicultural systems and only when applied in the absence of a Sustained
3639 Yield Plan. The purpose of this retention is to maintain and improve tree species diversity, genetic
3640 material and seed production, and is achieved by requiring the leave trees to be of the best phenotypes
3641 available. These trees need not be retained during the final, removal step. Otherwise, the Forest
3642 Practice Rules relegate hardwood retention during timber harvest to standards developed during plan
3643 development and agency review such as “Maintain functional wildlife habitat in sufficient condition for
3644 continued use by the existing wildlife community within the planning watershed” (CCR 897(b)(B)), and
3645 the “Hardwood Cover” evaluation requirements of the Cumulative Impacts Technical Rule Addendum #2
3646 (CCR 912.9, , 932.9, 952.9 (c)(4)(e).

3647 Outside of the timber harvest regulatory arena, some landowners may be actively suppressing
3648 hardwood competition with the more economically valuable conifers. In these situations, the
3649 Department has no authority to identify or mitigate impacts by recommending retention standards.
3650 Some landowners have developed internal standards that they apply during and outside timber harvest
3651 operations. While these may assure specimens and some level of hardwood function are retained on
3652 timberlands, the Department is unaware of the empirical support for the efficacy of these levels to
3653 provide spotted owl habitat and to support spotted owl forage base.

3654 *Regulatory Mechanisms Considerations*

3655 Changes in nesting and roosting habitat and dispersal habitat assessed for the NWFP have provided an
3656 assessment of broad landscape changes across the range of the Northern Spotted Owl, including
3657 changes specific to physiographic regions within California. As has been demonstrated at territory-based
3658 studies of habitat in California and southern Oregon, Northern Spotted Owl habitat is composed of a
3659 mosaic of mature forests intermixed with younger forest types within the home ranges of individual
3660 owls (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007), with particular
3661 combinations providing high quality habitat. Some of the forest types included in high quality Northern
3662 Spotted Owl home ranges are younger forests, which would have been considered foraging habitat in

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3663 the NWFP modeling, and therefore were not assessed for change in the recent review of the NWFP.
3664 Detection of changes in habitat quality at the smaller scale of Northern Spotted Owl home range
3665 requires an assessment of management practices at this scale, and can be accomplished by evaluating
3666 timber harvest practices around known Northern Spotted Owl activity centers.

3667 For core and home range habitat use, studies have documented a more concentrated and frequent use
3668 of habitat features surrounding the activity center (e.g., Hunter et al. 1995, Bingham and Noon 1997,
3669 Meyer et al. 1998, Zabel et al. 2003, USFWS 2009). In addition, the shape of core area use varies due to
3670 the availability of nesting, roosting and foraging habitat, which deviates from the typical circular
3671 representation or core habitat use. The percent of older forest represented within the home range area
3672 varies from 30-60%, with an average of about 45% (USFWS 2009). For a more detailed discussion on
3673 core and home range use, see Biology and Ecology section of this report.

Comment [EMG29]: Rosenberg and McKelvey (1999) is another key reference for central place foraging for NSOs.

3674 As discussed in the Habitat Requirements section of this report, certain habitat characteristics have been
3675 shown to support high quality Northern Spotted Owl territories, with both the amount and spatial
3676 configuration of different habitat types at a territory contributing to levels of survival and productivity in
3677 the resident owls. This measure of habitat quality at the scale of Northern Spotted Owl home range has
3678 been termed “habitat fitness potential” (HFP; Franklin et al. 2000). See the Habitat Effects on Survival
3679 and Reproduction section of this report for a discussion of HFP and additional studies that have
3680 contributed to an understanding of habitat characteristics that provide high HFP. The studies that have
3681 evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types
3682 that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent
3683 and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

3684 The definition of take under federal ESA includes actions that would reduce the quality of habitat;
3685 therefore, take avoidance recommendations by the USFWS can provide a reasonable baseline to assess
3686 impacts to habitat quality. Estimation of the likelihood of take according to Section 9 of the ESA would
3687 benefit from a better understanding between habitat quality and owl fitness. When the Forest Practice
3688 Rules were originally created, the criteria for owl habitat and retention were based on the best science
3689 and expert opinion at the time and lacked information on reproduction, survival and occupancy.

3690 The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the
3691 Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls
3692 may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis
3693 conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from
3694 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory
3695 loss. They found on private timber lands there was a 54% decline in pair status to no response, and a
3696 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change
3697 pair status. A lack of owl responses and a lack of suitable habitat to support continued occupancy and
3698 survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early
3699 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat
3700 characteristics to owl fitness, the USFWS asserted that the Forest Practice Rules were insufficient to

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adequately avoid take of Northern Spotted Owls (USFWS 2009), although we are not aware of any legal cases under the current regulatory framework.

To address insufficiencies in the Forest Practice Rules, the USFWS used the results of demography studies (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005) and additional studies on habitat selection by Northern Spotted Owl (e.g., Solis and Gutiérrez 1990, Zabel et al. 1993, Irwin et al. 2007), to develop harvest management guidelines for the interior and coast that would adequately avoid take of Northern Spotted Owl in California (USFWS 2008b). The purpose of the USFWS guidelines was to enable CAL FIRE to more effectively and appropriately evaluate THPs and NTMPs to result in timber harvest activities that do not result in take of owls according to ESA standards. To accompany the guidelines, the USFWS developed a white paper (USFWS 2009) describing the regulatory and scientific basis for developing the criteria within the guidance for the interior region of California. The USFWS did not develop a sister document for the coast region in California. Because criteria in the USFWS 2008 guidelines were developed using the most up to date scientific information for habitat effects on owl fitness within the core and home range areas, the guidelines differ somewhat from the Forest Practice Rules. Criteria noted in the Forest Practice Rules Section 919.9 subdivision (g) and the USFWS 2008 and 2009 guidelines are summarized in Tables 20, 21 and 22 below. Definitions of owl habitat referred to in Forest Practice Rules Section 919.9(g) can be found in Appendix 2.

Among the recommendations in the USFWS guidance to CAL FIRE (USFWS 2008b), minimum amounts of nesting, roosting, and foraging habitat are described for both 0.5 mile (502 acres; interior forests) and 0.7 mile (985 acres; coastal forests) radius surrounding the activity center, representing the core habitat use, and for an outer ring of habitat from 0.5 to 1.3 miles radius (2,908 acres; interior forests) surrounding the activity center, representing broader home range. The USFWS determined that within the interior forests in California, 0.5 mile radius, rather than the 0.7 mile radius noted in the Forest Practice Rules, more effectively captured actual core habitat use of Northern Spotted Owls (USFWS 2009). The 2008 USFWS guidelines also revised the definitions of nesting, roosting, and foraging habitat for the interior, and included differentiation between high quality and low quality habitat (USFWS 2008b and USFWS 2009). Although assumptions were required in order to develop a single set of guidelines for the interior forests, the amount and spatial configuration of habitat to be retained is consistent with what was found in studies that evaluated habitat quality as a function of owl fitness.

When the Northern Spotted Owl guidelines were added to the Forest Practice Rules in 1992, the intent was to protect Northern Spotted Owls and suitable habitat used for nesting, roosting and foraging. Since that time, additional scientific literature (e.g., Franklin et al. 2000, Irwin et al. 2000, Zabel et al. 2003, Courtney et al. 2004, Dugger et al. 2005, Glen et al. 2004, Olson et al. 2004, Irwin et al. 2007) has been published that helps to further elucidate habitat use of Spotted Owls and associations between habitat and owl fitness. It is also known that response and occupancy rates have declined at some historical activity centers. Though the specific reasons why response and occupancy rates have declined are unknown, there are multiple likely factors including cumulative habitat loss and degradation, and presence of Barred Owl. Given this broad range of possibilities, the Forest Practice Rules may not be sufficient at protecting loss of Northern Spotted Owl habitat within its range in California.

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3740 **Table 20.** Criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted
3741 Owls on private timberlands according to Forest Practice Rules Section 919.9(g).

Forest Practice Rules Subsection	Proximity to Activity Center (acreage)	Criteria Description
919.9(g)(1)	Within 500 feet of the activity center (~18 acres)	Characteristics of functional nesting habitat must be retained.
919.9(g)(2)	Within 500-1000 feet of the activity center (1,000 foot radius circle is ~72 acres)	Retain sufficient functional characteristics to support roosting and provide protection from predation and storms.
919.9(g)(3)	Within a 0.7 mile radius of the activity center (~985 acres)	Provide 500 acres of owl habitat. The 500 acres includes the habitat retained in subsections 919.9(g)(1) and (2) and should be as contiguous as possible.
919.9(g)(4)	Within 1.3 miles of each activity center (~3,400 acres)	Provide 1,336 total acres of owl habitat. The 1,336 acres includes the habitat retained within subsections 919.9(g)(1)-(3).
919.9(g)(5)	Shape of habitat retention	Areas established shall be adjusted to conform to natural landscape attributes such as draws and stream courses while retaining the total area required within subsections 919.9(g)(1) and (2).

3742

3743 **Table 21.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of
3744 Northern Spotted Owls on private timberlands, and selected stand structural parameters used to classify
3745 nesting/roosting and foraging habitat for Northern Spotted Owls in the northern coastal region of California
3746 (USFWS 2008b).

Habitat Type	Acre Retention in Core Area (within 0.7 mile; ~985 acres) ¹	Acre Retention in Outer Ring (between 0.7-1.3 mile) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	DBH	Percent Canopy Cover	Basal Area
Nesting/Roosting	200 acres	NA	200 acres	≥ 11 inch	≥ 60%	≥ 100 ft ² /acre
Foraging	≥ 300 acres	NA	≥ 300 acres	≥ 11 inch	≥ 40%	≥ 75 ft ² /acre
Suitable Habitat ²	NA	≥ 836 acres	≥ 836 acres			

3747 ¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the
3748 plan.

3749 ² Suitable Habitat is defined as habitat that meets either Nesting/Roosting or Foraging definitions, or a combination of
3750 Nesting/Roosting and Foraging habitat.

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3751 **Table 22.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted Owls on private timberlands,
3752 and selected stand structural parameters used to classify nesting/roosting and foraging habitat for Northern Spotted Owls in the northern interior region of
3753 California (USFWS 2008b and 2009).

Habitat Type	Within 1,000 feet of Activity Center	Acre Retention in Core Area (within 0.5 mile; ~500 acres) ¹	Acre Retention in Outer Ring (between 0.5-1.3 mile; ~2,900 acres) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	Basal Area Parameter	Quadratic Mean Diameter Parameter	Large trees/acre Parameter	Canopy Closure Parameter
High Quality Nesting/Roosting	No timber operations are allowed other than use of existing roads.	100 acres	NA	100 acres	≥ 210 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Nesting/Roosting		150 acres	NA	150 acres	Mix, ranging from 150 to ≥ 180 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Foraging		100 acres	655 acres	755 acres	Mix, ranging from 120 to ≥ 180 ft ² /acre	≥ 13 inch	≥ 5	≥ 40%
Low-quality Foraging		50 acres	280 acres	330 acres	Mix, ranging from 80 to ≥ 120 ft ² /acre	≥ 11 inch	NA	≥ 40%

¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the plan.

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3756 A comparison of the habitat definitions and retention requirements in Section 919.9(g) of the Forest
3757 Practice Rules (Appendix 2 and Table 20) and the revised take avoidance guidance provided by the
3758 USFWS (2009; summarized in Table 21 and 22) reveals how implementation of the Forest Practice Rules,
3759 as written, may result in degradation of habitat quality around Spotted Owl activity centers in the
3760 interior portion of the range. The definition of functional nesting habitat under the Forest Practice Rules
3761 might be adequate to provide suitable nesting or roosting habitat for spotted owls, although the
3762 average stem diameter is less than that recommended by the USFWS. The functional roosting habitat
3763 under Forest Practice Rules does not meet the requirements of roosting habitat under the USFWS
3764 recommendation; habitat falling under the roosting habitat definition would be considered low-quality
3765 foraging habitat under the USFWS recommendations. Functional foraging habitat as defined under
3766 Forest Practice Rules might meet the requirements for low-quality foraging habitat as defined by
3767 USFWS, but does not meet the requirements of foraging habitat.

3768 Under the Forest Practice Rules minimum retention requirements, stands that meet the USFWS
3769 recommendation for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
3770 The habitat retained within 1,000 feet (~72 acres) would be defined as low-quality foraging habitat in
3771 the USFWS guidance. Because the 500 acres of spotted owl habitat to be retained within 0.7 miles and
3772 the total of 1,336 acres to be retained within 1.3 miles of an activity center can be composed of
3773 functional foraging habitat, there is no requirement in the Forest Practice Rules for the retained habitat
3774 within 0.7 or 1.3 miles of the activity center to include nesting or roosting habitat. Also, using the revised
3775 habitat definitions provided by USFWS (2009), this retained foraging habitat could be of low quality.
3776 Although similar acreage of habitat is retained under the Forest Practice Rules and the USFWS
3777 recommendations, very little of the habitat retained under Forest Practice Rules is required to meet the
3778 requirements of nesting or roosting habitat. Consequently, depending on how the rules are
3779 implemented, management could result in a reduction in habitat quality around Northern Spotted Owl
3780 sites and could lead to declines in survival, productivity, and overall fitness.

3781 **Habitat Loss from Marijuana Cultivation**

3782 Large-scale marijuana cultivation in remote forests throughout California has increased since the mid-
3783 1990s, coinciding the time the “Compassionate Use Act” was passed in 1996 (Proposition 215) that
3784 allows the legal use and growth of marijuana for certain medical purposes (Bauer et al. 2015). Within
3785 the range of the Northern Spotted Owl, Shasta, Tehama, Humboldt, Mendocino, and Trinity counties
3786 comprise the areas known for the most marijuana cultivation in California due to the remote and rugged
3787 nature of the land, making cultivation difficult to detect (National Drug Intelligence Center 2007, Bauer
3788 et al. 2015). Illegal marijuana cultivation grows on public and private land are widespread in California
3789 (Gabriel et al. 2013, Thompson et al. 2013, Office of National Drug Control Policy 2015), and may also
3790 negatively impact owl habitat through degradation and removal, though data on the extent of this
3791 impact is not well known. The Office of National Drug Control Policy (2015) reported that in 2012 3.6
3792 million plants were eradicated from 5,000 illegal outdoor marijuana grow sites in the United States, of
3793 which 43% were removed from public and tribal lands. Additionally, the USFS reported that 83% of the
3794 plants removed were from California (Office of National Drug Control Policy 2015). Areas with higher

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3795 prevalence of marijuana cultivation may also contain high numbers of Northern Spotted Owl activity
3796 centers (see Figure 3), especially in areas where riparian habitat exists.

3797 As discussed previously, for typical timber harvest activities, land owners are bound by the Forest
3798 Practice Rules and would therefore need to submit a THP, Spotted Owl Management Plan, Spotted Owl
3799 Resource Plan or exemption notification to the appropriate governing agencies. However, small scale
3800 timber removal in association with legal marijuana cultivation on private land does not require review or
3801 approval from state or federal governments as long as the timber is not sold. Habitat alteration also
3802 occurs in association with illegal marijuana grow sites, but the extent is not well known due to the
3803 secretive nature of these activities. Therefore, loss of timber and other habitat components important
3804 to Northern Spotted Owls (e.g., riparian habitat alterations) for the cultivation of marijuana for such
3805 purposes is largely unregulated.

3806 To date, there has been no study that analyzes the impact of marijuana cultivation sites on Northern
3807 Spotted Owl habitat or fitness. However, there is a potential for negative impacts of sites placed on
3808 private and public land within the owl's range. The level of impact would likely depend on density of
3809 cultivation sites in proximity to owl activity centers, and whether sites are placed within suitable owl
3810 habitat.

3811 In an effort to assess potential environmental impacts to aquatic ecosystems from legal marijuana
3812 cultivation, Bauer et al. (2015) delineated cultivation sites (outdoor plantations and greenhouse
3813 locations), using Google Earth satellite imagery from 2011 and 2012, within four watersheds (hereafter
3814 referred to as the study area): Upper Redwood Creek, Redwood Creek South, and Salmon Creek, located
3815 in Humboldt County; and Outlet Creek, located in Mendocino County. In addition to the Bauer et al.
3816 (2015) study area, cultivation sites in the Mad River Creek watershed, in Mendocino and Trinity
3817 counties, were also delineated due to interest in identifying potential impacts to aquatic species and
3818 water quality in that area. Cumulatively, these 5 watersheds represent approximately 4% of the
3819 Northern Spotted Owl range in California (Table 23). Within these watersheds, marijuana cultivation
3820 sites varied in size from 0.002 to 2.9 acres and comprised a total of 362 acres. This is a relatively small
3821 portion of the watersheds assessed.

3822 **Table 23.** The number of marijuana cultivation sites within each watershed, and area (acres) associated with each.
3823 Watersheds assessed are within Humboldt, Mendocino, and Trinity counties.

Watershed Name	Area (acres)	No. of Cultivation Sites	Total area (acres) of Cultivation Sites
Upper Redwood Creek	155,338	253	43
Redwood Creek South	16,653	369	53
Salmon Creek	23,489	515	42
Outlet Creek	103,554	795	90
Mad River Creek	321,972	416	134

3824

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To assess potential impacts to Northern Spotted Owls we assessed marijuana cultivation locations from 2011 and 2012 within the watersheds mentioned in Table 23, together with owl activity centers locations (Figure 19). We found that no activity centers were within delineated cultivation sites; however, 10 activity centers are within 0.5 miles of the cultivation sites, and 96 within 1.3 miles. Depending on the size of the site and how much suitable owl habitat is removed, impacts to owls may vary. The amount and type of owl habitat removed is summarized in Table 24. For the cultivation sites delineated in 2011 and 2012, much of the habitat removed was unsuitable for Northern Spotted Owls, with the exception of Mad River Creek watershed; here, 12.45 acres of highly suitable, 6.89 acres of suitable, and 22.91 acres of marginal owl habitat was removed.

Table 24. Level of owl habitat removed in each watershed.

Watershed Name	Highly Suitable	Suitable	Marginal	Unsuitable
Upper Redwood Creek	2.67	3.56	22.91	8.9
Redwood Creek South	1.11	1.33	14.90	32.47
Salmon Creek	0.00	0.89	12.23	20.68
Outlet Creek	3.56	5.56	15.35	38.25
Mad River Creek	12.45	6.89	22.91	8.90

Comment [EMG30]: Is this acres? Please give units.

As described elsewhere in this report, habitat removal, fragmentation, and degradation can all have varying degrees of negative impacts on spotted owls depending on how much suitable habitat is removed within their core range (e.g., represented by the 0.5 mile buffer surrounding the activity center) and within their home range (e.g., represented by the 1.3 mile buffer surrounding the activity center). Of the 362 acres of forestland or riparian habitat removed for marijuana cultivation, approximately 20 acres are within highly suitable Northern Spotted Owl habitat, 18 acres are in suitable habitat, and 97 acres are in marginal habitat. As an example of potential impacts to Northern Spotted Owl activity centers, Figure 20 shows a zoomed in area in Humboldt County where marijuana cultivation sites overlap the home range for several activity centers. One activity center displayed in Figure 20 experienced removal of 4.45 acres of highly suitable habitat, 0.67 acres of suitable, 4.45 acres of marginal, and 0.89 acres of unsuitable habitat within the 1.3 mile buffer.

The data used for this analysis comes with certain limitations when assessing long-term impacts to the Northern Spotted Owl. First, the dataset is a snapshot in time during 2011 and 2012 and does not represent expansion of cultivation sites since the data were collected. The data also only covers 4% of the Northern Spotted Owl range and therefore is only representing a small area of potential impact. Marijuana cultivation is occurring outside of the area assessed. To more fully consider impacts a similar analysis would have to be done within the entire range. In addition, smaller clearings (less than 10 mi²) are likely not captured in the dataset due to difficulties identifying and delineating smaller sites using aerial imagery and not all sites locations are reported as required by law. Sites likely have not been captured for other reasons as well; for example, some sites are intentionally placed in areas where they are harder to detect (e.g., sites with higher canopy closure). Law enforcement efforts and ground truthing helped fill in the gaps for the data collected in 2011 and 2012, but it is still uncertain how many

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3858 sites were not accounted for. Lastly, there may be other activities associated with the cultivation sites
3859 not captured using this data that can also have an impact in owl, such as placement of roads and
3860 vehicular traffic.

3861 Given above uncertainties regarding the dataset used in this analysis, it is plausible to assume that the
3862 density of cultivation sites is likely higher than represented in the dataset. In addition, given the density
3863 of cultivation sites within Humboldt, Trinity and Mendocino counties represented in this analysis, and
3864 the fact that the watersheds analyzed comprise only 4% of the Northern Spotted Owl range, it is also
3865 very plausible to assume that marijuana cultivation sites are impacting spotted owl habitat, thereby
3866 likely impacting fitness to some extent.

3867 **Wildfire**

3868 *Effect of Wildfire and Salvage Logging*

3869 Wildfire is a natural process in California's forests, and in much of its range the Northern Spotted Owl
3870 has evolved in a landscape of frequent wildfire. Despite this, fire is often considered a primary threat to
3871 Northern Spotted Owl habitat due the owl's preference for older forests and the capacity of fire to
3872 rapidly remove or degrade habitat. The mature forests preferred by owls for nesting and roosting can
3873 take decades to centuries to develop following removal, depending on location and forest type and fire
3874 severity. The USFWS revised recovery plan (USFWS 2011) considered fire to be a primary threat to the
3875 Northern Spotted Owl, along with ongoing losses to timber harvest and competition with the Barred
3876 Owl. As discussed above, fire has become the primary cause of nesting and roosting habitat loss on
3877 federal lands since implementation of the NWFP, only surpassed by rangewide losses due to timber
3878 harvest, which have been concentrated on nonfederal land (Davis et al. 2011).

3879 The majority of the natural disturbance loss (e.g., disease, insects, wildfires) of nesting and roosting
3880 habitat on federal lands since 1994 has occurred in the five relatively dry physiographic provinces
3881 (eastern Washington, eastern Oregon, and California Cascades; Oregon and California Klamath; Figure
3882 21), with about 86% (211,300 acres) of the natural disturbance loss occurring in these provinces (Davis
3883 et al. 2011).

3884 These dry provinces contain only about 42% of the total nesting and roosting habitat acreage on federal
3885 lands rangewide. Most habitat loss in the dry provinces was due to wildfire in the Oregon and California
3886 Klamath and the eastern Washington and eastern Oregon Cascades (Davis et al. 2011). Degradation of
3887 nesting and roosting habitat from fire was also estimated, with most degradation occurring in the
3888 western Cascades (Davis et al. 2011).

3889 Research on the effect of wildfire on Spotted Owl habitat use and selection, occupancy, and survival has
3890 been conducted throughout the range of the species from eastern Washington and southern Oregon, in
3891 the Sierra Nevada mountains in the range of the California Spotted Owl, and in Arizona and New Mexico
3892 in the range of the Mexican Spotted Owl (e.g., Gaines et al. 1997, Bond et al. 2002, Jenness et al. 2004,
3893 Bond et al. 2009, Clark et al. 2011, 2013). Studies to date are scattered throughout the range of the

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3894 Spotted Owl and have generally been performed opportunistically due to the difficulties associated with
3895 experimental fire research in a natural setting; much uncertainty remains on the effect of wildfires on
3896 the extent and quality of Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates
3897 by Spotted Owls have been somewhat equivocal, in some cases showing that stand replacing wildfire
3898 has a negative impact on occupancy (e.g., Gaines et al. 1997), and in other cases showing no adverse
3899 impact of wildfire on Spotted Owl occupancy (e.g., Jenness et al. 2004). Here we focus on the relatively
3900 extensive studies from the Sierra Nevada Mountains in the range of the California Spotted Owl and from
3901 southwestern Oregon in the range of the Northern Spotted Owl, as these areas more closely represent
3902 the forest types within the interior range of the Northern Spotted Owl in California and are relatively
3903 well studied.

3904 In the southern Sierra Nevada, in areas with a mosaic of burned and unburned forests, California
3905 Spotted Owls have been shown to use forests that have experienced a full range of burn severities. Bond
3906 et al. (2009) found the degree to which a post-fire site was used varied with burn severity and with the
3907 function of the site in meeting various life history requirements (i.e., nesting, roosting, or foraging). This
3908 study occurred in an area that experienced the full range of burn severities, resulting in owl territories
3909 with a mosaic of all burn classes, ranging from unburned forests to areas with most of the overstory
3910 removed by fire (high-severity burn areas were defined as those resulting in high to complete mortality
3911 of dominant vegetation; low-severity burn areas were defined as those with little change in cover and
3912 little tree mortality; moderate-severity burn areas were those between high- and low-severity, with a
3913 mixture of effects on vegetation). Most California Spotted Owl roost sites (85%) occurred in unburned
3914 and low-severity burn areas, and owls avoided roosting in moderately and severely burned areas.
3915 Conversely, California Spotted Owls selected foraging sites represented by all severities of burned forest
3916 and avoided unburned forest (Bond et al. 2009). This study illustrated that California Spotted Owls use
3917 multiple forest types within a home range to meet nesting, roosting, and foraging needs, and that
3918 moderate to high severity fires may impact preferred nesting and roosting habitat while providing
3919 foraging habitat. In contrast to the findings of Bond et al. (2009), recent work on the impact of fire on
3920 foraging site selection by California Spotted Owls in Yosemite National Park showed that owls selected
3921 for areas of low-severity burns but avoided areas of high-severity burns (Eyes 2014). The owls that were
3922 tracked in the burned areas of the southern Sierra Nevada (Bond et al. 2009) were shown to have a diet
3923 composed of predominately pocket gophers (Bond et al. 2013), whereas the diet of California Spotted
3924 Owls in unburned forests was dominated by woodrats and northern flying squirrels, depending on
3925 location. Breeding home range sizes were similar for owls occupying burned and unburned areas (Bond
3926 et al. 2013). The apparent shift to an alternative prey source in the post-fire landscape of the Sierra
3927 Nevada may have allowed California Spotted Owls to effectively utilize high-severity burn areas and to
3928 maintain similar home range sizes.

3929 The use of a diverse forest composition in the Sierra Nevada is consistent with research conducted in
3930 the range of the Northern Spotted Owl that indicate high quality habitat is composed of older more
3931 mature forest among a mosaic of other forest types (Franklin et al. 2000, Olson et al. 2004). California
3932 Spotted Owls in the Sierra Nevada also selected for foraging sites that included edge between burned
3933 and unburned forests and between burn areas of different severity classes (Bond et al. 2009). This is

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3934 consistent with the above studies on Northern Spotted Owls which showed high quality habitat to have
3935 high amounts of edge between old forests and other forest types.

3936 In a study of post-fire occupancy at six fire sites across the range of the California Spotted Owl in the
3937 Sierra Nevada, Lee et al. (2012) found no difference in occupancy rates between burned and unburned
3938 sites. As with the above study on post-fire habitat selection, this study included fires with a range of
3939 burn severities, which is typical of fires in the Sierra Nevada (Odion and Hanson 2006). Of the six fires
3940 included in the study, on average 32% of the burned area was burned at high-severity so these results
3941 are applicable to mixed-severity fires that result in a mosaic of post-fire conditions. A subset of burned
3942 sites included in the study (9 of 41) burned at higher severity (>50% high severity burn of suitable owl
3943 habitat). Owls were detected at five of these nine sites post-fire (Lee et al. 2012), suggesting that sites
3944 that were exposed to higher amounts of high-severity fire might have experienced reductions in
3945 occupancy, but this was not modeled. Salvage logging of timber after a fire was known to occur on eight
3946 burned sites post-fire. California Spotted Owls initially occupied seven of the eight sites after the fire,
3947 but following the salvage logging none of the sites remained occupied. Post-fire logging may have
3948 adversely affected occupancy of burned sites but the sample size was too small for the effect to be
3949 modeled (Lee et al. 2012). An additional study in the Sierra Nevada compared occupancy rates at 10
3950 unburned sites to 9 sites that burned at low to moderate severity in Yosemite National Park and found
3951 no difference in occupancy rates between burned and unburned sites (Roberts et al. 2011). The study
3952 area was restricted to areas with $\geq 40\%$ canopy cover, and occupancy was positively correlated with total
3953 tree basal area and canopy closure (Roberts et al. 2011). This study did not address effects of high-
3954 severity fire, nor post-fire logging.

3955 In the range of the Northern Spotted Owl, the most extensive evaluation of the effect of fire on owls has
3956 been conducted on a group of three fires in the Klamath and Western Cascades physiographic provinces
3957 of southwest Oregon (Clark 2007, Clark et al. 2011, 2013). By tracking radio-marked owls with territories
3958 inside and adjacent to burned areas, Clark et al. (2011) were able to estimate the effects of fire on
3959 occupancy and survival of Northern Spotted Owls. The occurrence of a demographic study area (South
3960 Cascades) in proximity to the fires allowed for comparison of unburned areas to pre- and post- fire rates
3961 within the fire footprints. On one of the fire study areas (Timbered Rock fire), 22 territories had been
3962 surveyed for ten years pre-fire and so allowed for a comparison of pre- and post- fire occupancy.
3963 Occupancy at this site was compared to the nearby South Cascades study area and the two areas were
3964 shown to have similar trends in occupancy rates prior to the Timbered Rock fire in 2002. However,
3965 extinction rates in the Timbered Rock fire area increased after the fire, resulting in declines in occupancy
3966 (Clark 2007, Clark et al. 2013). Only 20% of territories at the Timbered Rock fire were occupied by a pair
3967 of owls by the end of the study period in 2006 (four years post fire), where >50% of territories had been
3968 occupied in all years pre-fire. These declines were not observed at the unburned South Cascades study
3969 area. Data collected at all three fires from 2003-2006 was used to model post-fire rates and suggested
3970 that high extinction rates and low colonization rates led to declines in post-fire occupancy (Clark 2007).

3971 On two of the burned areas in southwest Oregon (Timbered Rock and Quartz fires), 23 radio-marked
3972 Northern Spotted Owls were tracked over a one year period in order to estimate survival rates of owls
3973 within and adjacent to burns. Mean annual survival rates of owls displaced by wildfire (0.66 ± 0.14) or

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3974 occupying territories within the burned area (0.69 ± 0.12) were lower than those for owls outside of
3975 burned areas (0.85 ± 0.06) (Clark et al. 2011). Survival rates of owls outside of burned areas were similar
3976 to rates at the nearby unburned demographic study area (South Cascades; 0.85 ± 0.01) (Anthony et al.
3977 2006). The two fires included in the survival study each burned about 50% of the owl habitat at mixed
3978 severities from low to high, which is comparable to fires included in studies on California Spotted Owl in
3979 the Sierra Nevada. Of the 24 owls tracked, 5 died during the study. Necropsies were performed on 4 of
3980 these owls and showed that all were severely emaciated and likely died due to starvation (Clark et al.
3981 2011). This, and the fact that owls in the study maintained larger home ranges post-fire (Clark 2007),
3982 suggest that food limitation might have played a role in reduced survival rates. Also, the documented
3983 dispersal of several adult Northern Spotted Owls out of the burn area at the Timbered Rock fire 1-2
3984 years post-fire suggests that insufficient habitat remained at abandoned territories to support an owl
3985 pair (Clark et al. 2013). Both of the fire areas in this study were salvaged logged post-fire, with about
3986 20% of the area logged in each fire. See discussion on potential effects of salvage logging below.

3987 Using the telemetry data collected by Clark in southwest Oregon, Comfort (2013) evaluated selection of
3988 habitats relative to availability following mixed-severity fire disturbance. The strongest predictor of
3989 spotted owl presence was habitat suitability (as defined in the 10-year review of the Northwest Forest
3990 Plan (Davis and Lint 2005)). Northern Spotted Owls avoided large, contiguous patches of high-severity
3991 disturbance and preferentially used areas of lower severity disturbance (Comfort 2013). At small spatial
3992 scales (<0.8 ha), Spotted Owls did select for areas with hard edge created by high severity fire, but at
3993 larger spatial scales, hard edges were avoided. This suggests that at the scale of a home range, owls
3994 selected for large patches of contiguous high suitability habitat interspersed with small patches (<0.8 ha)
3995 of high severity fire or salvage logging (Comfort 2013). Because salvage logging occurred in the study
3996 area on private industry land, the analysis by Comfort did not distinguish between areas of high-severity
3997 burns and those that were salvage logged, but instead used the combined disturbance of fire and
3998 logging to evaluate owl use of different components of the landscape.

3999 An earlier study evaluated short term survival of Spotted Owls following wildfire by tracking color-
4000 banded owls which occurred on territories that later burned in a wildfire during a period from 1985-
4001 2001 (Bond et al. 2002). Because of the opportunistic nature of observations for this study, only 11
4002 territories were included in the study and they were distributed across the range of the species from
4003 California, Arizona, and New Mexico, and represented all three subspecies of the Spotted Owl. Twenty-
4004 one color-banded owls had occurred on the eleven territories pre-fire and 18 were resighted the year
4005 following fire (Bond et al. 2002). This represents a simple annual survival estimate of 86%, which is
4006 similar to reported estimates of survival in unburned areas. The short-term covered by the study (one
4007 year post-fire) and the small sample size limit the utility of the study in extrapolating to a general effect
4008 of fire on Northern Spotted Owls (of which four territories were included), but they do at least
4009 demonstrate that some wildfires have little short-term impact on Spotted Owl survival. Most territories
4010 in this study burned at low to moderate severity and no salvage logging had occurred between time of
4011 fire and the following year when resighting attempts occurred (Bond et al. 2002).

4012 Post-fire declines in occupancy in southern Oregon contrast with most results for the California Spotted
4013 Owl in the Sierra Nevada. As mentioned above, two of three burn areas in southern Oregon underwent

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fairly extensive salvage logging post-fire. The studies conducted in the Sierra Nevada included some sites that were salvage logged, but sample sizes were too small to model the perceived effect of logging on occupancy. Several authors have suggested that salvage logging after a fire or occurrence of extensive high severity burns likely have contributed to a decline in habitat use, occupancy, or survival of Northern Spotted Owls (Bond et al. 2009, Roberts et al. 2011, Clark et al. 2011, 2013, Lee et al. 2012). With the exception of low severity burns, burned areas have generally not supported nesting habitat but have been shown in some cases to create foraging habitat. The presence of snags has been suggested as an important component of prey habitat and as perch sites for foraging Spotted Owls. We do not know of any research conducted on Northern Spotted Owl prey abundance in burned vs. unburned forests, but early successional forests have been shown to support abundant woodrat populations in the southern portion of the range (see discussion of prey in Life History section) and so burned areas may provide high quality prey habitat once vegetation regrowth produces an understory. Bond et al. (2009) concluded that the most likely explanation for high probability of use by foraging California Spotted Owls of forest patches that experienced high severity burns was increased prey promulgated by enhanced habitat conditions, including increased shrub and herbaceous cover and number of snags, and provided the following discussion on the importance of snags to Spotted Owl prey:

“Snags provide shelters for prey species like woodrats and flying squirrels. In the southern Sierra Nevada, dusky-footed woodrat nests are common where shrubs encircle rock outcrops or snags (Lawrence 1966). Bushy-tailed woodrat (*N. cinerea*) densities in dry forests of eastern Washington, USA, were strongly correlated with arboreal and terrestrial cover in the form of large snags, mistletoe, and large soft logs (Lehmkuhl et al. 2006). Northern flying squirrel population densities in Oregon, USA, were correlated with the occurrence of suitable nesting cavities in trees and early decay-stage snags with diameters >50 cm (Volz 1986).”

Lee et al. (2012) argued that snags play an important role in suitable California Spotted Owl habitat in burned areas. This was based on observations that occupancy decreased when ≥ 20 ha of mature conifer forest was logged within a 400-ha circle surrounding a California Spotted Owl site (Seamans and Gutiérrez 2007), whereas when an average of 32% of suitable habitat within a 400-ha circle burned at high severity no negative effect on occupancy is observed. In southern Oregon, Clark et al. (2013) modeled the effects of fire severity, salvage logging, and pre-fire habitat characteristics on occupancy by Northern Spotted Owls. They found that extinction probabilities increased as the combined area of pre-fire harvest, high-severity burn, or salvage logging increased, resulting in reduced occupancy of nesting territories by Northern Spotted Owls; however, they were unable to distinguish the effect of salvage logging from the other effects (i.e. these factors collectively contributed to declines in occupancy). Observational studies and occupancy modeling conducted to date suggest that post-fire landscapes that are salvage logged experience declines in Spotted Owl occupancy. However, other factors such as initial habitat conditions (e.g., area of pre-fire harvest), the amount and distribution of high-severity fire, regional differences in forest composition and fire history, and differential subspecies response may also influence occupancy. Based on results to date that suggest an impact of salvage logging, Bond et al. (2009) recommended that burned forests within 1.5 km of nests or roosts of California Spotted Owls not

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be salvage logged and Clark et al. recommended restricting salvage logging after fires within 2.2 km of Spotted Owl territories in the range of the Northern Spotted Owl in southern Oregon.

Fire Regime in the Northern Spotted Owl Range

When the USFWS subdivided the range of the Northern Spotted Owl into 12 physiographic provinces, information on fire disturbance regimes was used to inform boundaries (USFWS 1992). Efforts to map the fire-prone portion of the Northern Spotted Owl range since then have generally followed physiographic province boundaries, with the drier provinces of the eastern and California cascades and the Oregon and California Klamath provinces generally considered more fire-prone (e.g., see Rapp 2005, Spies et al. 2006, and Healey et al. 2008). As part of an evaluation of the NWFP, a recent effort to model fire-prone areas used fire history and environmental predictor variables to map the likelihood of large wildfire occurrence throughout the range (Davis et al. 2011). Although this approach did not use existing physiographic province boundaries or other lines used to delineate fire-regimes across the Northern Spotted Owl range to inform the model, results are generally similar to previous descriptions based on broad geographic regions (Figure 22(a)). See Davis et al. (2011) for discussion and potential explanation of differences between model results and previous predictions of fire-prone regions in the eastern and western Oregon Cascades.

Regardless of methodology used, all attempts to map fire-prone areas consistently include large portions of the Northern Spotted Owl range in California, with much of the California Klamath and California Cascades highly prone to fire disturbance. By overlaying the modeling results for fire-prone areas with the Northern Spotted Owl habitat suitability map, Davis et al. (2011) showed that the physiographic province with the most owl nesting and roosting habitat in fire-prone landscapes is the California Klamath Province. This is evident when looking at actual fire history from 1950 to 2013 (Figure 22(b)). Over the last several decades, large acreage fires have been prevalent on the landscape within the Klamath Province.

Within the fire-prone regions of California, fire regimes vary depending on a number of factors, with broad differences noted between the mixed conifer/mixed hardwood forests characteristic of the Klamath Province and the ponderosa pine forests that dominate some portions of the Cascade Province and eastern Klamath Province. The following discussion of historical and current fire regimes in California focuses on these two provinces, as these are the two regions where fire is most likely to have an impact on the Northern Spotted Owl.

Historical Fire Regime in the Klamath Province

As described in the Habitat section of this report, the Klamath Province is an area with extremely high floristic diversity and heterogeneity. This diversity arises from complex patterns in topography, soils, and climate throughout the region, which results in complex vegetation and contributes to a diverse fire regime. The natural fire regime acts in a positive feedback manner to contribute to vegetation heterogeneity and diversity (Odion et al. 2004, Skinner et al. 2006). The dominant conifer species across most of the low and mid-elevations in the Klamath Province is the Douglas-fir, and depending on local

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conditions a wide variety of conifer species may co-occur with this dominant species. At higher elevations, the dominant conifer grades into white fir, and at the highest elevations, a diverse set of subalpine conifer species can occur. Low and mid elevations are characterized by an equally diverse set of hardwood species that form lower canopy layers of mixed conifer hardwood forests and can also occur as pure stands. This occurrence of diverse hardwoods in coniferous forests of the Klamath region may reduce fire severity, and following fire may lead to more rapid recovery by sprouting (Odion et al. 2004, Spies et al. 2006). In drier eastern portions of the Klamath Province, ponderosa pine can be the dominant or co-dominant conifer. Because of the greater extent of ponderosa pine-dominated forests in the California Cascade Province, this forest type is discussed below.

Throughout the Klamath Mountains in the presettlement period most forest stands experienced at least several fires each century, suggesting a mixed fire regime of frequent low- to moderate-intensity fires (Skinner et al. 2006), with low-severity fire composing the largest portion of burned area, and high-severity fire the smallest portion (Agee 1993). Low-severity fire has been defined as those which kill less than 20% of the basal area; high-severity fire causes high tree mortality, with mortality of 70% and above used to define high-severity burns (Agee 1993, Hessburg et al. 2005). Under stable atmospheric conditions, current fires tend to follow a mixed fire regime similar to historical patterns (Taylor and Skinner 1998, Odion et al. 2004). Variation within the mixed-severity fires of the Klamath region has been strongly influenced by topography in both the presettlement and contemporary periods (Taylor and Skinner 1998). As described by Skinner et al. (2006),

“Generally, the upper third of slopes and the ridgetops, especially on south- and west-facing aspects, experience the highest proportion of high-severity burn...The lower third of slopes and north- and east-facing aspects experience mainly low-severity fires. Thus, more extensive stands of multi-aged conifers with higher densities of old trees are found in these lower slope positions. Middle slope positions are intermediate between lower and upper slopes in severity pattern.”

This topographically-controlled fire regime is the most widespread regime in the Klamath Mountains and is controlled by greater heating and drying on certain portions of mountain slopes and climatic variables in deep canyons (Skinner et al. 2006). Temperature inversions that often occur while fires are burning enhance this topographic pattern of fire intensity (Skinner et al. 2006). Historical fires were patchy and relatively small, although fires of up to several thousand acres were relatively common, and the majority of burned areas experienced low and moderate severity fire (Spies et al. 2006). The frequent occurrence of mixed-severity fires created a diverse landscape of older forest with variable openings of younger forest and nonforested areas, with the relative composition of these forest types varying depending on slope position.

Historical Fire Regime in the Cascades Province

South of the latitude of Mt. Shasta in the California Cascades, the vegetation composition and species dominance of lower and mid-montane forests is similar to that in the northern Sierra Nevada, and upper montane forests are more similar to the Klamath Mountains (Skinner and Taylor 2006). Conifer forests dominate the mid-montane zone on both sides of the Cascade Range and are intermixed with

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woodlands and shrublands. On the west side of the Cascades, mixed-species conifer forests dominate with any of six conifer species co-occurring or sharing dominance (Skinner and Taylor 2006). A subcanopy of mixed hardwoods may occur beneath the conifer canopy. Extensive areas on the east side of the Cascade Range are dominated by either ponderosa pine or Jeffrey pine (collectively referred to as yellow pine; Skinner and Taylor 2006). These forests are less complex than those on the west side with fewer co-occurring species of conifer and with relatively poor-developed understory historically. Accordingly, yellow pine-dominated forests had a distinct, more uniform fire regime.

Forest species composition and structure in the different portions of the Cascades Province is related to fire regime, with areas of mixed-severity fire regimes that occur in the Klamath and portions of the Cascades frequently supporting multi-storied old growth and the drier forests further east (dominated by yellow pine) experiencing more frequent, low-severity burns and decreased diversity (Spies et al. 2006). As in the Klamath Mountains, fire-severity in the California Cascades is associated with topographic position with the high-severity portion of burns more likely to occur on upper slopes and the low-severity burns occurring predominately on lower slopes. This pattern is less pronounced in the Cascades than in the more extreme terrain of the Klamath Mountains (Skinner and Taylor 2006). As in the Klamath region, in regions of the Cascades where fire regime is influenced by topography multi-aged and multi-sized forests are concentrated on the lower slopes and more even-aged stands that develop after high-severity burns mostly occurred on upper slopes (Skinner and Taylor 2006).

The portion of the Northern Spotted Owl range which is dominated by ponderosa pine is relatively uncommon and is distributed in a narrow band on the east side of the Cascades and in limited areas in southwestern Oregon and northern California (Spies et al. 2006). Jeffrey-pine-dominated forests occupy the lower elevations on south-, east-, and west-facing slopes in eastside environments (Skinner and Taylor 2006). These forests occur in the driest portions of the northern spotted owl range. Ponderosa and Jeffrey pine dominated forests have a distinctly different structure and historical fire regime in comparison to the mixed conifer forests of the rest of the Klamath and Cascade provinces. Historically, frequent low-severity burns resulted in low and variable tree densities, with low, patchy developed understory, and reduced fuel loads (Hessburg et al. 2005). Frequent burns favored fire-tolerant tree species such as ponderosa pine and maintained fire-tolerant forests by elevating tree crowns and consuming many small and medium sized trees (Hessburg et al. 2005). The forest structure and composition in these yellow pine forests that resulted from frequent fires reinforced the occurrence of low-severity fires by limiting the conditions that could support high severity fires (Hessburg et al. 2005). Historical open yellow pine forests would not have provided all necessary habitat conditions for the Northern Spotted Owl, but local areas of high density and complex structure likely provided requirements for nesting and roosting (Davis et al. 2011) among a landscape of mixed forest types and nonforest areas.

Recent Changes in Fire Regimes and Possible Causes

Multiple potential causes have been implicated in increasing fire activity over the last several decades. The success of fire suppression and exclusion has indirectly advanced secondary succession in forests and changed forest composition by increasing tree density, decreasing prevalence of fire-tolerant tree

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4170 species (e.g., ponderosa pine and Jeffrey pine), and contributing to homogenization of forest structure.
4171 In some cases, timber harvest has directly advanced secondary succession through the selective removal
4172 of the largest trees (Hessburg et al. 2005). Post-harvest tree plantations have created homogeneous
4173 forests dominated by even-aged, smaller-diameter trees that in some cases are less resistance to fire. In
4174 addition, climate variables, including temperature and precipitation, have produced conditions that
4175 promote increased amounts of fire activity.

4176 Beginning in the early 1900s in accessible areas and in the mid-1900s in remote areas, fire suppression
4177 caused a dramatic decline in fire occurrence in the Klamath province (Skinner et al. 2006). The result was
4178 a series of decades, beginning in the early 1900s, with dramatically reduced fire extent over most of the
4179 Klamath region (Taylor and Skinner 1998, 2003; see Figure 23 for example). During this period the fire
4180 rotation (time required to burn an area equal to a defined area of the landscape) increased to an
4181 estimated 974 years in the early 1980s (Miller et al. 2012) compared to a historical estimate for fire
4182 rotation of only 20 years (Taylor and Skinner 2003). In the Cascade Province the fire suppression period
4183 began in the early 1900s. The gentler slopes of the Cascade Province, relative to the Klamath region,
4184 lead to successful fire suppression efforts. This success resulted in a dramatic change in fire frequency
4185 from high frequency low-severity fires to a period of minimal fire occurrence in the California Cascades.

4186 Following several decades of reduced extent and frequency of fire as a result of fire suppression efforts,
4187 the average fire size has increased in recent decades (beginning in the 1980s) across the western United
4188 States (Schwind 2008, Westerling et al. 2006), including the area comprising the Northern Spotted Owl
4189 range in California (Odion et al. 2004, Miller et al. 2012). The area burned annually within the entire
4190 range of the Northern Spotted Owl (Davis et al. 2011) and within the California portion of the range
4191 (Miller et al. 2012) also increased dramatically during this time and the regional fire rotation fell to 95
4192 years by 2008 (from a high of 974 years in the early 1980s). As noted in Figure 24, the years between
4193 1970 and 2009 with the most area burned per year in the California portion of the Northern Spotted Owl
4194 range have all occurred since 1987 (Davis et al. 2011, Miller et al. 2012). Mixed-species forests on the
4195 west side of the California Cascades have changed with the success of fire suppression, with forest
4196 density increasing and species composition shifting toward fire-sensitive white fir (Norman and Taylor
4197 2002, Skinner and Taylor 2006). Although the Cascades portion of the Northern Spotted Owl range in
4198 California has not experienced the number or extent of uncharacteristically large fires that have
4199 occurred in the Klamath province, in recent years several large fires have burned in the eastern Cascades
4200 of Oregon and Washington and in the southern portion of the California Cascades. The gentler
4201 topography of the Cascades is more conducive to extensive fires than the Klamath region (Norman and
4202 Taylor 2003, Skinner and Taylor 2006); where forests have developed high densities of young trees due
4203 to fire suppression, fires that escape fire suppression efforts can become large and burn at high-severity
4204 (Skinner and Taylor 2006).

4205 Although there is evidence that the increase in fire size in recent years has corresponded with an
4206 increase in fire severity in the western U.S., including the Sierra Nevada (Hessburg et al. 2005, Schwind
4207 2008, Miller et al. 2009), trends in burn severity have been less conclusive than trends in fire size and
4208 total area burned (Schwind 2008). There is evidence from both the Klamath and Cascade provinces of
4209 California that the proportion of fire-severities in recent mixed-severity fires has been consistent with

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4210 historical patterns, or that change has only been evident in most recent years (Odion et al. 2004, Hanson
4211 et al. 2009, Miller et al. 2012).

4212 Some researchers have challenged the common perception that fire suppression and fuel build-up is the
4213 main cause of increased fire activity. In their study of large fires in the Klamath Mountains, Odion et al.
4214 (2004) evaluated fire history from 1977 to 2002 and concluded that fuel build-up in the absence of fire
4215 did not occur, and instead fuel that is receptive to combustion may decrease in the long absence of fire
4216 in the study area. These authors also evaluated patterns of burn severity in a nearly 100,000-ha fire that
4217 burned in the Klamath Mountains in 1987 to test the effect of fire history, past timber management, and
4218 vegetation structure on the extent and severity of current fire. Odion et al. (2004) found that multi-
4219 aged, closed forests generally burned at low severity, even where fire suppression efforts had limited
4220 fires over the previous decades. The same study found that areas with a history of high-severity fire and
4221 areas with large amounts of even-aged tree plantations experienced elevated amounts of high-severity
4222 fire. These findings are counter to the common assumption that increased extent of high density forests
4223 will lead to increased occurrence of high-severity fire. The additional findings suggests that the historical
4224 pattern of mixed-fire regime in the Klamath continues to drive patterns of at least some contemporary
4225 fires and can act to maintain diverse, heterogeneous forests (Odion et al. 2004).

4226 Miller et al. (2012) conducted a broad assessment of patterns in the extent of high-severity fire in four
4227 national forests of northwestern California. Their study covered all fires larger than 100 acres during the
4228 years 1910 to 2008 in a 5.8 million acre area including the northern California Coast Range and the
4229 Klamath Mountains, as well as a portion of the southern Cascade Range. This study area covers most of
4230 the range of the Northern Spotted Owl on federal land in California. Although the authors observed
4231 significant increases in both fire size and total annual area burned from 1910 to 2008, they found no
4232 temporal trend in the percentage of high-severity fire in recent years.

4233 Despite the findings of Odion et al. (2004) and Miller et al. (2012), at least one recent fire, the Biscuit
4234 Fire of 2002, has occurred in the Klamath province that was not only large but was of uncharacteristic
4235 high-severity (Skinner et al. 2006). The Biscuit Fire burned about 500,000 acres in southern Oregon and
4236 northern California. Almost 224,000 acres (49%) burned at high severity, with 75-100% canopy tree
4237 mortality, and an additional 14% of the burn area experienced 50-75% mortality (USFS 2003). This large,
4238 relatively high-severity burn was inconsistent with historical burn patterns and was associated with
4239 weather conditions that are conducive to fire (i.e., high winds and low humidity). Conversely, in the
4240 years when the most area has burned in the Klamath province of California since the 1980s, fires have
4241 primarily been caused by region-wide lightning events that strain fire suppression resources and that are
4242 associated with more moderate meteorological conditions. Overall fire severities were relatively low in
4243 these years due to the long duration of fires, weather conditions, and strong inversion events (Miller et
4244 al. 2012).

4245 Steel et al. (2015) presented evidence that the response of fire regime to past fire suppression varies
4246 with forest type and the degree to which fire in an ecosystem is fuel-limited or climate-limited. Forests
4247 with fire regimes that are more fuel-limited (e.g., yellow pine forests and mixed conifer forests found in
4248 much of the interior portion of the Northern Spotted Owl range in California) should experience

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4249 increases in fire severity following periods of fire suppression, whereas forests with fire regimes that
4250 have been historically climate-limited (e.g., redwood forests) would be less altered by a history of
4251 suppression. Using data on fire severity for 660 fires that occurred on USFS land in California between
4252 1984 and 2011, Steel et al. (2015) showed that the proportion of fires burning at high severity has
4253 increased for fuel-limited forest types. This increase in severity was correlated to indicators of fire
4254 suppression for much of California; however, the Klamath bioregion did not show this relationship. This
4255 suggests that fire severity, or at least the occurrence of high severity fire in the Klamath bioregion may
4256 be more limited by climate than by fuel loads. This may explain inconsistent observations of fire severity
4257 trends for the Klamath region, with measured proportions of high intensity fire varying on a case-by-
4258 case basis, depending on climatic conditions during the fire.

4259 Where increases in fire size or severity have been observed in recent years in forests of the western
4260 United States, it has often been attributed to increased densities of fuels and development of ladder
4261 fuels as a consequence of fire suppression. Fire suppression and exclusion in ponderosa pine forests has
4262 been successful at reducing the frequency of fire which allowed for the development of shade-tolerant
4263 trees and understory vegetation in the previously open forests, and resulted in an increase in stand
4264 density (Taylor 2000). Resource-stressed stands are more susceptible to insects and disease which
4265 results in an increase in weakened or dead trees and heavy fuel loadings (Hessburg et al. 2005, Davis et
4266 al. 2011). This has led to fuel characteristics in ponderosa pine forests that can support larger and more
4267 severe wildfires (Hessburg et al. 2005). Large, severe fires in the dry eastern Cascades of Oregon and
4268 Washington have occurred in recent years (Davis et al. 2011), and the potential remains for the loss of
4269 large amounts of nesting and roosting habitat.

4270 Past management practices that have established more homogeneous even-aged forests (e.g., fire
4271 suppression, livestock grazing, and timber harvest practices) may provide forest conditions that are
4272 conducive to high-severity fires in forests with fire regimes that were historically fuel-limited. Repeated
4273 selection cutting of the largest trees had the effect of advancing secondary succession, resulting in
4274 younger forests with higher density, fire-intolerant trees (Hessburg et al. 2005). Recent large, high-
4275 severity fires and timber harvest practices have expanded the amount of even-aged plantations,
4276 hardwood stands, and shrublands (Skinner et al. 2006). Prior to fire suppression, the forest landscape in
4277 the Klamath Mountains contained stands of even-aged forests, but they do not appear to have occupied
4278 extensive areas (Taylor and Skinner 1998, 2003, Skinner et al. 2006). Odion et al. (2004) reported that
4279 plantations occur in one-third of the roaded landscape in their large fire study area in 1987. Extensive
4280 areas of young even-aged forests that have resulted from a combination of past fire and past timber
4281 harvest practices may amplify conditions for repeated high-severity fires compared to heterogeneous
4282 forests that were created by historical patterns of mixed-severity fires (Spies et al. 2006). A positive
4283 feedback resulting from past timber management and fire suppression practices, existence of increased
4284 even-aged stands in the forest matrix, and future high-severity fire has the potential to support a new
4285 forest matrix with stable or increasing amounts of even-aged forest and decreased heterogeneity
4286 (Skinner et al. 2006).

4287 Several studies have determined a strong link between changes in fire extent, severity and season, with
4288 low precipitation and high temperatures. In addition to land-use history over the last century, climate

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variables (e.g., precipitation, temperature) have been evaluated as potential causes of recent increases in large wildfires. There is an important distinction between these two potential causes. Changes in forests brought about by land-use history may be reversible through management actions, such as forest thinning and prescribed fire, while reversing trends in climate warming are unlikely in the near future (Westerling et al. 2006, Littell et al. 2009). Littell et al. (2009) found that in areas with low fuel loads the impacts could be lessened through fuel reduction prescriptions, however in areas that are experiencing low precipitation, this may prove less useful).

Under various climate change scenarios (as discussed in the Climate Change section of this report), fire seasons have been predicted to be longer and fire sizes larger (McKenzie et al. 2004, Westerling and Bryant 2008, Littell et al. 2009, Miller et al. 2009, Westerling et al. 2011). For example, McKenzie et al. (2004) found that extreme fire weather (e.g., hot dry summers) in western America will influence the severity and the total area burned, with the duration of the fire season lengthened with more fires occurring early and later in the typical fire season. Westerling et al. (2006) found that periods with large fire occurrences corresponded with a shift toward warm springs and longer summer dry seasons, and suggested that both land use and climate have contributed to increased fire risk, but that broad-scale increases across the western U.S. were driven primarily by recent trends in climate.

Compared to pre-European settlement, Miller et al. (2009) found that high severity fires in low- to mid-elevation forests are increasing of California and western Nevada. Miller et al. (2009) suggests that snow water deficits, earlier snowmelt, lengthening of the fire season, worsening drought conditions, low fuel moisture, and increase of forest fuel availability all play a role in how forests are in a position to burn more often and at higher severity. In this study, types of forested land most impacted by high severity fires include those on National Forest land, those experiencing high resource extraction and rapid human population growth, and those supporting old growth dependent species (Miller et al. 2009).

Another study in the western United States supported theory that climate is a driving factor influencing fire extent in the 20th century, and fire regimes will vary dependent on fuel energy and water deficits (Littell et al. 2009). Low precipitation and high evapotranspiration in mountainous ecoprovinces of the western United States lead to low fuel moisture conditions; thus, creating a system at higher risk to combustion and fire spreading (Littell et al. 2009). Similar to Miller et al. (2009) findings, Littell et al. (2009) suggests low precipitation, warmer winters, reduced snowpack and drought effects lead to increases of forested area burned.

With future climate change, the continued occurrence of large, uncharacteristically severe fires may become increasingly common. These changes may in turn impact the habitat, distribution and abundance of sensitive species such as the Northern Spotted Owl.

Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat

Variation in fire severity has an important influence on forest structural diversity because low-severity fires kill few trees while high-severity fires may kill all trees in a stand (Taylor and Skinner 2003). High-severity fires tend to result in even-aged stands while lower severity fires result in forests with multiple

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age classes. In much of California, the Northern Spotted Owl evolved in a landscape of frequent, mixed-severity fire, with most burns occurring at low severity and a relatively small amount of burns occurring at high severity. In the drier portion of the Northern Spotted Owl range, the species is likely adapted to the heterogeneous landscape resulting from regular, mixed-severity fire. Prior to fire suppression, the frequent occurrence of mixed-severity fires in large portions of the Klamath and Cascade ranges, along with the resulting complex landscape (e.g., older forests with openings of other forest types intermixed with nonforested areas) was prominent throughout the region. The historical mixed fire regime in the Klamath region may have benefited Northern Spotted Owl habitat by maintaining areas of older forests with dense canopies and complex structure, while also providing a heterogeneous landscape composed of multiple forest ages and structure. This pattern could have supported high quality habitat mosaics of nesting and roosting habitat and diverse foraging habitat which lead to high survival and reproductive success (Franklin et al. 2000).

Current fire regime and its potential to impact Northern Spotted Owl habitat depends on a number of factors including: fire management history, logging history, forest type, historical fire regime, weather patterns and climate change. Additionally, observed impact to Northern Spotted Owl is likely complicated by occurrence of post-fire salvage logging. Although forest heterogeneity has decreased with recent management practices, the forests of the Klamath Mountains continue to provide habitat for Northern Spotted Owl. More information is needed on the effect of historical fire suppression and current fire regimes on owl habitat, especially on the quality of habitat as assessed through demographic rates at individual owl territories. Most fires in the Klamath region continue to burn under historical mixed regimes that can contribute to a heterogeneous forest landscape. However, recent large fires are cause for concern for the future stability of forest conditions in the region, especially considering the higher percentage experiencing high-severity burns. Large amounts of Northern Spotted Owl nesting and roosting habitat has been lost to wildfire since implementation of the NWFP, with the majority being lost in a few very large fires (e.g., the Biscuit Fire of 2002) (Davis et al. 2011). Fires have been more frequent during dry years (Cook et al. 1996) and extreme weather events influence the occurrence of large, landscape-scale fires (Miller and Urban 2000). Wildfire has been the leading cause of nesting and roosting habitat loss on federal lands in recent decades; if large fires continue to occur in the future, much more habitat may be lost.

Historical fire suppression and exclusion in ponderosa pine forests in the Cascades was successful at reducing the frequency of fire which allowed for the development of shade-tolerant trees and understory vegetation in the previously open forests, and resulted in an increase in stand density (Taylor 2000). This may have improved nesting and roosting habitat conditions for Northern Spotted Owls in these forests compared to the pre-suppression period. However, high densities of younger trees as a result of fire suppression and timber management practices have created conditions with potential for stand-replacement fires in ponderosa pine forests. Ideally a landscape-scale management strategy for these forests would retain large, dense patches of forests embedded in a matrix with reduced stand densities to limit the potential for stand-replacement fire and competitive pressure on old trees (Thomas et al. 2006).

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With the complexity of fire regimes in the state, the sometimes equivocal effects on Northern Spotted Owls, the uncertain contribution of fuel build-up, and climate influences on future fire frequency and severity, there has been disagreement on the level of risk that fire poses in the dry portions of the Northern Spotted Owl range. Hanson et al. (2009) reported that the risk of fire to Northern Spotted Owl habitat in the dry provinces had been overestimated in the 2008 Recovery Plan, which included ongoing loss of habitat as a result of timber harvest and fire as threats to the Spotted Owl (USFWS 2008a). This claim of overestimation was made based on calculated rates of old-forest recruitment exceeding rates of high severity fire in old-forests (Hanson et al. 2009). Spies et al. (2010) criticized the findings of Hanson et al. (2009), stating that an incorrect threshold was used to estimate extent of high severity fire and that an incorrect depiction of error was used to support selection of the threshold. Spies et al. (2010) also disagreed with the methodology used by Hanson et al. (2009) to estimate the rate of recruitment of old forests.

This debate on the risk of fire to Northern Spotted Owl habitat has important management implications. If recent and projected changes in fire size or severity continue to remove large amounts of nesting and roosting habitat, fuel treatments (e.g., thinning and prescribed fire) to reduce fire risk may have long-term benefits to owls by encouraging the development and maintenance of older forest patches while limiting the risk of stand-replacing fires. However, if recent large high severity fires are an anomaly and recruitment of old forest outpaces losses to high severity fire, natural processes can be incorporated into management plans to shape Spotted Owl habitat on the dry province landscape. Hanson et al. (2010) recommended small-scale experiments to study owl response to fuel treatments rather than large-scale implementation. Risks are not likely to be uniform across the range, with ponderosa pine forests likely having a different response to past management than mixed-conifer forests of the Klamath, for example. The 2011 Revised Recovery Plan recommends formation of working groups to inform management in both the Klamath and dry Cascade provinces (USFWS 2011a).

Climate Change

According to global and regional climate scenarios, many species will be required to adapt to changes in temperature, precipitation, forest structure, etc., or face eminent declines or extirpation. The degree of threat varies based on species and region. Climate change scenarios have been modeled across the range of the Northern Spotted Owl, including in California. Several studies have been conducted to assess the threat to Northern Spotted Owl specifically.

Climate Change Projection Modeling

In California, a multitude of climate change studies have been conducted. As noted by Pierce et al. (2012), a common theme among the California-specific studies indicates temperature showing a consistent positive trend, but changes in precipitation vary. Generally, most studies agree that California will retain its Mediterranean climate of cool/wet winters and hot/dry summers, yet the degree of wetness/dryness will be amplified (Lenihan et al. 2003, Cayan et al. 2012).

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The projected climate model simulations from Cayan et al. (2012) exhibit warming over California, with a mid-century rise of approximately 1°C to 3°C (1.8°F to 5.4°F), and 2°C to 5°C (3.6°F to 9°F) rise by end-of-twenty-first century. Pierce et al. (2012) showed an average yearly increase in temperature over California of 2.4°C by the 2060s, with coastal areas showing less warming (1.9°C) than interior areas (2.6°C). Westerling and Bryant (2008) predicted an average increase of 4.3°C in California by 2070–2099. Seasonally, the summer and fall months exhibit greater warming than winter and spring months (Cayan et al. 2012, Pierce et al. 2012), with the degree of warming increasing as one moves from the coast to the interior of the state (Cayan et al. 2012). Extreme temperature events (i.e., frequency of extreme hot days) will become more common place and may take place earlier in the season (Cayan et al. 2012).

Climate projection modeling conducted by Cayan et al. (2012) show a high degree of variability between month-to-month and year-to-year precipitation with slight drying tendencies in some areas of California, which may suggest that California will remain at risk to drought and flooding events, with more prominent changes in the southern portion of the state than the northern portion. Seasonal changes in precipitation included a somewhat contracted wet season, with less precipitation during late winter and spring than during the core winter months (Cayan et al. 2012). Pierce et al. (2012) found precipitation decreased overall in the southern portion of California (<10%) by the 2060s, but remained unchanged from historical levels in the northern portion of the state. Seasonally, winters in the northern portion of the state were wetter and offset by drier conditions the rest of the year by the 2060s, while the southern part of the state showed moderate decreases in fall, winter, and spring but stronger increases in summer (Pierce et al. 2012).

Dalton et al. (2013) summarizes climate projection models for the Coastal, Cascade and Rocky Mountain ranges of Washington, Oregon and Idaho (e.g., Northwest). This paper indicates that the region showed an overall increase of temperature year-round (warming of at least 0.5 °C (0.9 °F) in every season), but more prominent warming during summer months. Modeling showed mixed results for annual precipitation, indicating little change from present (models ranged from –4.7% to +13.5%). Seasonally, most models showed a decrease in precipitation during summer months and increased precipitation during the other seasons (the largest projected change of about –30%). Dalton et al. (2013) climate models are in agreement that heat extremes will increase and cold extremes will decrease. Along the Northwest coast, sea level rise was projected to rise 4 to 56 in (9–143 cm) by 2100, with significant local variations.

Climate Change Impacts to Forests

In the Northwest and in California, changes in precipitation and temperature may impact forest distribution, growth, and structure (Lenihan et al. 2003, Dalton et al. 2013, Vose et al. 2012, McIntyre et al. 2015). Most climate projection models indicate upward elevational shift and a northward latitudinal shift in forest habitats (Vose et al. 2012). In climate projection scenarios specific to California, Lenihan et al. (2003) noted the most notable response to increase temperature was a shift from conifer-dominated forests to mixed conifer-hardwood forests in the northern half of the state (e.g., the replacement of Douglas fir-white fir forest by Douglas fir-tan oak forest in the northwest) and an expansion of conifer forests into the northeast portion of the state (e.g., Modoc Plateau) by the 21st century. McIntyre et al.

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(2015) found similar results when comparing historic forest survey data (1930s) with recent surveys (2000s) to elucidate forest structure and composition shifts over time within the entire latitudinal extent of forests in California. This study found that today's forests are exhibiting an increase dominance of oaks (*Quercus*) at the expense of pines (*Pinus*). McIntyre et al. (2015) also found that across the 120,000km² study area, large trees declined by 50% with a 19% decline in average basal area and associated biomass since the early 1900s. Understanding the shifts in structure and species composition is complex, but McIntyre et al. (2015) partially attributed these shifts to water deficits within California forests (e.g., drought), while acknowledging other contributing factors such as logging and fire suppression (McIntyre et al. 2015). Conifer-dominated forests (e.g., redwood and closed-cone pine forests) along the north-central coast of California (e.g., Crescent City south to Monterey) were projected to advance, resulting in redwood forests shifting inland into Douglas-fir-tan oak forests (Lenihan et al. 2003). Dalton et al. (2012) found that Douglas-fir forests in the Northwest may experience substantial declines through the 21st century. Tree productivity along California's north-central coastal and at high elevation forests was shown to increase in response to increased growing season temperatures; however, increases in productivity along the coast would only be seen if there was a persistence of coastal summer fog (Lenihan et al. 2003). Lenihan et al. (2003) suggests that if summer fog were to decrease in concert with increased temperatures, productivity of redwood forests along the coast would suffer reductions, or worse, would be eliminated entirely.

Vulnerability to disturbance, such as wildfire, disease and insect outbreaks, is expected to increase in most forests in the Northwest and may change forest composition and structure depending on changes to climate (Dalton et al. 2012, Vose et al. 2012). According to Davis et al. (2011), one of the objectives of US Forest Service is to develop projections for wildfire regimes and habitat shifts due to changing climate and increased threats from wildfire, disease and insect outbreaks. Vose et al. (2012) effectively summarizes the nationwide effects of climate driven disturbance as follows:

- Wildfire will increase causing a doubling of area burned by mid-21st century
- Insect infestations (e.g., bark beetle in the western US) will expand
- Invasive species will likely become more widespread, and especially in areas with increased disturbance and in dry forests
- Increased flooding, erosion and sediment transport caused by increase precipitation, area of large burned areas, and rain-snow ratios
- Increases in drought occurrences, exacerbating other disturbances (e.g., fire, insect outbreaks, invasive species), which will lead to higher tree mortality, decreased regeneration in some tree species, and alteration of tree species composition and structure

Climate modeling studies agree that forest wildfire occurrence and severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and longer drier summers (Swetnam 1993, National Assessment Synthesis Team 2000, Houghten et al. 2001, Lenihan et al. 2003, Westerling et al. 2006, Westerling and Bryant 2008, McKenzie and Littell 2011, Vose et al. 2012). Spracklen et al. (2009) projected that forests of the Pacific Northwest forests will experience increases in mean annual area burned, with a projected increase of 175% by 2050 compared to areas

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burned between 1996 and 2005. This increase will likely negatively impact old-growth forests and the species that inhabit them (Dalton et al. 2012, Vose et al. 2012). By evaluating fire history and climatic data in forested areas across the western United States over a 34-year period, Westerling et al. (2006) tested the contributions of land use and climate conditions on occurrence of large fires. Over this study period, the frequency and size of wildfires showed a marked increase in the mid-1980s; a large portion of this increase occurred in the range of the Spotted Owl in California (Sierra Nevada, southern Cascades, and Coast Ranges of northern California). The period of increase in large fire occurrence corresponded with a shift toward warm springs and longer summer dry seasons (Westerling et al. 2006). The authors concluded that both land use and climate have contributed to increased fire risk, but that broad-scale increases across the western U.S. were driven primarily by recent trends in climate. For California as a whole, by the end of the 21st century, risk of large fire will increase between 12 and 53 percent compared to observed fire regimes between 1980 and 1999, and for northern and southern California, large fires will increase 15 to 90 percent and -29 to 28 percent, respectively (Westerling and Bryant 2008). See the Wildfire section above for more detailed discussion on wildfire impacts to forest systems.

Climate Change Impacts to Northern Spotted Owl

Northern Spotted Owls utilize older structurally complex forests, in part, to facilitate thermoregulation and to provide protection from predators. Forest type and age within owl habitat varies by region. Coastal regions are wetter and cooler and tend to be redwood species dominant and of a younger age class, whereas inland regions are drier and warmer and tend to be mixed conifer/hardwood or Douglas-fir dominant.

Most climate projection scenarios agree that the forests in the Northern Spotted Owl's range will have wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased frequency and intensity of disturbance events. According to many climate projections, the frequency and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will increase over time. Extreme climatic variation has been linked to sudden large-scale mortality in avian populations in the past (Tomba 1971, Johnson et al. 1991, and Smith et al. 1991 as cited in Franklin et al. 2000), and the literature studying Spotted Owl response to climate supports this.

Northern Spotted Owl survival is thought linked to precipitation patterns. Olson et al. (2004) stated that survival was negatively associated with early-nesting season precipitation, and positively associated with late-nesting season precipitation. Population growth for Northern Spotted Owls range-wide (Washington, Oregon and California) was positively associated with wetter conditions during the growing season (May through October) due to more favorable conditions for prey species, but negatively associated with cold/wet winters and nesting seasons, and during hot summers on four of the six study areas (Glenn et al. 2010). Over the extent of late-successional reserve land covered by the NWFP, Carroll (2010) predicted that winter precipitation was closely associated with a decrease in Northern Spotted Owl survival and recruitment (i.e., the entirety of the Northern Spotted Owl range in Oregon, Washington and California). Using vegetation and climate variables, model results in Carroll

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4519 (2010) predicted an initial northward expansion of high quality owl habitat, followed by a contraction as
4520 climate variables intensify over time.

4521 In the Coastal and Klamath Mountains of northwestern California, Franklin et al. (2000) thoroughly
4522 examined the effects of climate on temporal and spatial variation of Northern Spotted Owl survival,
4523 reproductive output, and recruitment. In these models, climate explained most of the temporal
4524 variation in life history traits. The study suggested that the period most impacted by climate was during
4525 the spring, presumed largely due to higher energetic demands during the breeding season, as well as
4526 prey abundance and availability. Franklin et al. (2000) states, “extreme climate conditions during the
4527 early nesting period may exacerbate an energetic stress on an individual by decreasing it’s time to
4528 starvation.” However, the winter period did explain variation in recruitment, thought to be a function of
4529 reduced survival of young during their first year.

4530 In Oregon and Washington, Glenn et al. (2011) found a negative association between Northern Spotted
4531 Owl reproduction (number of young fledged) and cold wet nesting season, thought to be a function or
4532 loss of eggs or young to exposure or terminating incubation (Forsman et al. 1984). Whereas,
4533 reproduction was positively associated with late nesting season precipitation and negatively associated
4534 with warm temperatures, thought to be a function of reduced prey abundance and availability.
4535 Interestingly Glenn et al. (2011) also found that number of young fledged per year declined when
4536 precipitation in the year prior deviated from normal, and that number of young fledged per year
4537 increased following warm wet dispersal seasons. Some of these results differ from California studies
4538 such as Franklin et al. (2000), and may be a function of differing habitat, climate and targeted prey
4539 species. Regardless, the study suggests that Northern Spotted Owl reproductive success involves a
4540 complex relationship between prey populations, body condition and climate prior to and within the
4541 nesting season; a statement that, given the current literature on the species, certainly holds true for the
4542 species in California.

4543 The literature also indicates that Spotted Owls are sensitive to heat stress (Franklin et al. 2000,
4544 Weathers et al. 2001), which may be more problematic as temperatures rise over time. For the
4545 California Spotted Owl, Weathers et al. (2001) found that when temperatures reached between 30 and
4546 34°C, a relatively moderate level, owls increased behavioral heat responses (e.g., increase respiratory
4547 rate, gaping, wing drooping).

4548 As previously discussed, structural complexity (broken top trees, snags, overhead cover) is an important
4549 habitat component for Northern Spotted Owls. Structural complexity is an important factor in
4550 determining the availability of suitable nest sites. Rockweit et al. (2012) found that nest type selection
4551 played a role in Northern Spotted Owl reproductive success in California during period of inclement
4552 weather (i.e., low temperatures and high winds). Nests that were more exposed to the elements, such
4553 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at
4554 protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must
4555 include structurally complexity to provide nesting options with proper protection. The intensity of
4556 disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or
4557 detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced

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4558 when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may
4559 increase the level of structural complexity.

4560 Habitat loss and alteration due to heightened disturbance events (e.g., wildfire, disease, insect
4561 outbreaks), may also impact forest species, such as the Northern Spotted Owl, by intensifying
4562 competitive pressure from other species, such as Barred Owl (Lenihan et al. 2003, Carroll 2010).

4563 Direct mortality of Spotted Owls from wildfire will likely increase as frequency and intensity of wildfires
4564 increases. Indirect impacts may also include an increased level of predation if there is loss of older or
4565 structurally complex forests. However, neither direct mortality nor increased predation is specifically
4566 addressed in the literature.

4567 To better understand potential climatic impacts to Northern Spotted Owls, the Department compiled
4568 average 30-year (1980-2010) and 5-year (2010-2014) precipitation and temperature data and calculated
4569 the percent change within the owls range. Decreases in precipitation were most apparent in the
4570 southern portion of the coastal range (Marin, Sonoma and Mendocino counties), and within the interior
4571 range (Figure 25). Increases of precipitation were more limited, with increases seen in a small portion of
4572 northern Trinity County, and scattered within Humboldt and Del Norte counties. This analysis generally
4573 shows a drying trend throughout the owl's range, except in the northern portion of the coastal province
4574 and some small portion of the Klamath province.

4575 Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-
4576 August) and winter months (December-February) separately. Comparing the 30-year average with the 5-
4577 year average, temperature increases during the summer months were seen mostly within the north and
4578 northwest portions of Siskiyou County (northern portion of the Klamath and Cascade provinces), and
4579 along scattered portions of the coastal province (Figure 26). As shown in Figure 26, temperature
4580 decreases in the summer months were seen most prominently within the rest of the interior (Klamath
4581 and Cascade provinces). During the winter months, temperature increases were seen within interior
4582 (Klamath and Cascade provinces), while decreases were seen most prominently in the coastal province
4583 (Figure 27). This analysis generally shows warmer winters and cooler summers compared to normal
4584 within the interior portion of the Northern Spotted Owl range, and cooler winters and warmer summers
4585 along the coastal portion of the range.

4586 It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many
4587 climate projections forecasting steady changes in the future. Climate change studies predict future
4588 conditions that may negatively impact owls, such as wet and cold springs, more frequent and sever
4589 summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased
4590 frequency of severe wildfire events. Yet in some instances predicted future conditions, such as increased
4591 frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to
4592 the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change
4593 predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other
4594 areas of the range. Looking at past precipitation and temperature trends, drying trends across most of
4595 the owl's range in California coupled with warmer winters and cooler summers in the interior and cooler

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winters and warmer summers along the coast may play a role in both owl and prey population dynamics. More research is needed to assess the extent of these climate impacts on survival, population growth and reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of climate change outweigh the positive ones.

Barred Owl

Barred Owl Expansion and Current Status in California

Historically, Barred Owls were residents of the eastern United States and southern Canada, east of the Great Plains and south of the boreal forest, and also in disjunct regions of south-central Mexico (Mazur and James 2000). Based on genetic analysis, Barrowclough et al (2011) found the disjunct Mexican populations to be distinct from populations in the United States and Canada at the species level, and recommended they be recognized as *Strix sartorii*. Barred Owls continue to occupy their historical range, and during the past century have expanded their range to western North America.

The timing and route of the Barred Owl range expansion into western North America has been debated by the scientific community and is not resolved. An early and long-held view has been that Barred Owls expanded their range to the west via the boreal forests of Canada (Grant 1966, Hamer 1988, Houston and McGowan 1999, Holt et al. 2001). Livezey (2009a) suggested a slightly different pattern of expansion based on records for more than 12,500 Barred Owl detections from 1873 to 2008. He suggested that the expansion began via riparian forests of the Missouri, Yellowstone, and Musselshell rivers of the northern Great Plains to the forested mountains of western Montana at the end of the 19th century (Figure 28). From Montana, he suggests that Barred Owls then expanded their range in multiple directions, including to the north and then east, where they encountered Barred Owls that were expanding their range west through the boreal forests of Canada. Whether the initial range expansion was via the boreal forest of Canada or the riparian corridors of the northern Great Plains, once Barred Owls reached British Columbia in the 1940s, they continued their range expansion to the north and west across Canada to southeastern Alaska, and south through Washington, Oregon, and California (USFWS 2011a, USFWS 2013). The range of the Barred Owl now completely overlaps the range of the Northern Spotted Owl from southwest British Columbia south along the western portion of Washington, Oregon, and northern California, and also includes a significant portion of the range of the California Spotted Owl.

Barred Owls were first detected in California in 1976 (Dark et al. 1998, B. Marcot in Livezey 2009a). From then until 1996, 61 Barred Owl sites were identified in California (Dark et al. 1998). The majority of these sites (73%) were occupied by single owls. The first report of breeding in California was in 1991 (T. Hacking in Dark et al. 1998) and the first sighting in the Sierra Nevada was in 1991. The rate of detections of Barred Owls in California accelerated during the mid-1990s (Dark et al. 1998) and by 1996 Barred Owls had been detected as far south as Sonoma County in western California and Yuba County in the Sierra Nevada. Forsman et al. (2011, Appendix B) presented data showing that the rate of detection continued to accelerate through the 2000s. Currently, the known range of the Barred Owl in California

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4633 extends along the coast south to Marin County (Jennings et al. 2011, Ellis et al. 2013) and to Tulare
4634 County in the Sierra Nevada.

4635 The Department has processed data for 1,970³ Barred Owl occurrences in California (Figure 29), and 111
4636 additional occurrences of Barred-Spotted Owl hybrids. Occurrences include all detections of barred
4637 owls, whether or not they were associated with a nest or territory.

4638 Following the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two
4639 species have occasionally been observed. The majority of hybrids genetically sampled resulted from a
4640 cross between a female Barred Owl and a male Spotted Owl (Haig et al. 2004, Kelly and Forsman 2004).
4641 Generally second generation hybrids are difficult to distinguish from barred or Spotted Owls using field
4642 identification only and genetic samples may be the only sure way of identification (Kelly and Forsman
4643 2004). Both first and second generation hybrids were found to be reproductively viable to some extent
4644 (Kelly and Forsman 2004). Haig et al. (2004) found that the two species DNA sequences showed a large
4645 divergence and could be separated into distinct clades with no signs of previous introgression.

4646 *Potential Mechanisms of Barred Owl Range Expansion*

4647 Factors that may have facilitated the range expansion have been debated in the literature at length. As
4648 mentioned above, two possible routes for the initial expansion from eastern North America have been
4649 suggested (i.e., riparian forests of the northern Great Plains and the boreal forest of Canada). It has been
4650 speculated that an ecological barrier existed prior to the end of the 19th century and that changes, either
4651 anthropogenic or natural, removed the barrier, and allowed for the initial westward expansion of the
4652 Barred Owl range.

4653 The most prominent theory is that an increase in the number of trees and forested areas supported the
4654 expansion by providing suitable Barred Owl habitat where before there was none (e.g., within the Great
4655 Plains). The relatively fast Barred Owl range expansion coincides with a period of dramatic increases in
4656 wooded habitat across the northern Great Plains and the boreal forests of Canada following arrival of
4657 European settlers. Explanations for an increase in the number of trees are anthropogenic and include
4658 fire suppression, tree planting (including shelterbelts), extirpation of bison, and to a lesser extent
4659 reductions in beaver, elk and deer populations on the northern Great Plains due to market hunting (Dark
4660 et al. 1998, Wright and Hayward 1998, R. Gutiérrez in Levy 2004, Livezey 2009b). Livezey (2009b)
4661 evaluated the plausibility of barriers to range expansion that have been proposed. He provided strong

³ The 1,970 occurrences processed to date represent a subset of available data and come from 2 general sources: 1) state and private researchers, biologists and foresters from 1978-2013 and 2) the Forest Service's NRIS database with records from 1992-2011. Data omitted due to time constraints includes 1) hard copy data, 2) 2012-2013 NRIS detections and 3) NRIS detections that were within 1 mile of processed data to avoid duplicates; this data, not including duplicates, will be added in the future. An updated version of NRIS containing 2012 and 2013 detections is still needed. Additional data from the 2013 field season is also yet to be submitted. There is likely more data in holding and data from additional sources that has not been submitted.

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evidence that the northern Great Plains were largely treeless prior to the range expansion, a finding that supported a lack of habitat as a potential barrier. He also evaluated a number of anthropogenic changes (as noted above) preceding or coincident with the expansion and that are likely to have greatly increased the forest habitat in the region. Livezey concluded that the most plausible explanation for an ecological barrier that existed prior to range expansion, the removal of which coincided with range expansion, is an increase in forest habitat, first along the rivers and later in the boreal forest. Tree planting and fires suppression are obvious causes of the increase in wooded area, and the timing of these precedes the expansion of Barred Owl to the west. Huge numbers of bison destroyed small wooded areas on the Great Plains through rubbing on older trees and browsing or trampling of young trees (Livezey 2009b). The extirpation of bison precedes the increase in wooded habitat on the northern Great Plains. Elk, deer, and beaver have also been shown to have local effects on forest habitat, and may have contributed to suppression of forests in the Great Plains, especially in the limited wooded habitat along riparian corridors (Livezey 2009b).

Another theory is that increases in temperature may have improved habitat value for Barred Owls in the boreal forest (Johnson 1994, Wright and Hayward 1998, Monahan and Hijmans 2007). This theory is based on an assumption that the boreal forests of southern Canada were too cold to be tolerated by Barred Owls, and that a warming climate brought these forests into the range of temperature tolerance for the species, thereby eliminating a natural barrier to Barred Owl range expansion. Because portions of the current range of Barred Owls (e.g., northern Alberta and British Columbia, the Northwest Territories) are much colder than the forests of southern Canada, Livezey (2009b) rejected the hypothesis that a thermal barrier was preventing range expansion, but he suggests conducting additional research on the thermal tolerances of Barred Owls. Additionally, the temperature increase referenced in the literature occurred in part after the Barred Owl range expansion had begun (Johnson 1994, Monahan and Hijmans 2007), calling this mechanism of range expansion into question.

Once Barred Owls expanded across the middle of the continent, they encountered forests of the Rocky Mountains and the Pacific Northwest. Timber harvests may have facilitated the further expansion of the range by creating a mosaic of more open forest habitat that might be favored by a habitat generalist like the Barred Owl (Hamer et al. 1989, Dark et al. 1998). However, Barred Owls have become established in a variety of habitats, including mature forests that have not been harvested, challenging this as a factor in the further expansion of the range (USFWS 2013). Because Barred Owls are habitat and prey generalists (as explained below), the suggestion that they adapted to use of a novel (coniferous forest) habitat, which then allowed them to spread through the boreal forest and the forests of the west has largely been dismissed (Livezey 2009b, USFWS 2013).

Spotted Owl and Barred Owl Habitat, Prey Selection, and Home Range

Barred Owls tend to select low to high elevation areas with gentle slopes, large overstory tree with expansive crown diameter, and evergreen stands with a dense canopy, but will also nest in areas with young trees, deciduous tree species and open areas (Herter and Hicks 2000, Buchanan et al. 2004, Gremel 2005, Hamer et al. 2007, Jennings et al. 2011, Mazur and James 2000, Pearson and Livezey 2003, Singleton et al. 2010). Recently, Wiens et al. (2014) determined that Barred Owls selected a broad range

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4701 of forest types in western Oregon, but were more strongly associated with large hardwood and conifer
4702 trees within relatively flat areas along streams. In the eastern Cascades Range in Washington, Singleton
4703 (2015) found Barred Owls used structurally diverse mixed grand fir and Douglas-fir forests during the
4704 breeding season more often than open ponderosa pine or simple-structure Douglas-fir forests, with less
4705 selection among forest types during the non-breeding season. Spotted Owls may have a stronger affinity
4706 than Barred Owls to Douglas-fir dominant forests and more abundant dwarf mistletoe infestations, an
4707 important habitat feature for nesting Spotted Owls in the Washington’s eastern Cascades (Singleton
4708 2015). Similarities between Barred Owl and Spotted Owl habitat preferences include selection of old
4709 forests with closed canopy and a high degree of structural complexity for nesting and roosting activities
4710 (Mazur et al. 2000, Singleton et al. 2010, Wiens et al. 2014, Singleton 2015). As Wiens et al (2014) points
4711 out, the similar habitat preference for older forests highlights the importance for maintaining this forest
4712 type on the landscape because a decrease in older forests will likely increase competitive pressure
4713 between the two species. Differences of habitat selection include the tendency for selection of lower
4714 elevation sites with gentle slopes (e.g., valley floors) by Barred Owls, the use of a larger variety of forest
4715 types by Barred Owls, the stronger dependence on Douglas-fir dominant forests by Spotted Owls, and
4716 more abundant mistletoe infestations by Spotted Owls. Currently, there is no indication that the two
4717 species can coexist, sharing the same habitat and prey-base, because there is little evidence that nesting
4718 habitat or prey-base can be adequately partitioned to prevent competition (Gutiérrez et al. 2007, Dugger
4719 et al. 2011, Singleton 2015).

4720 Home range analyses show the importance of mature forests for nesting by both Barred and Spotted
4721 Owls; however, Barred Owls select other forest cover types similar to their availability whereas Spotted
4722 Owls are more tightly associated with old forests (Hamer et al. 2007, Singleton et al. 2010). Home ranges
4723 for both species have been found to be smaller in old mature forests; however, within forest types,
4724 home ranges of Spotted Owls are 3 to 4 times larger than those of Barred Owls (Hamer et al. 2007,
4725 Singleton et al. 2010, Wiens et al. 2014). In a western Oregon study, Barred Owl home range and core
4726 area use (i.e., the portion of the fixed-kernel breeding season home range in which use exceeded that
4727 expected under a null model of a uniform distribution of space-use) was 581 ha and 188 ha,
4728 respectively; whereas Northern Spotted Owl home range and core area use was much larger - 1843 ha
4729 and 305 ha, respectively (Wiens et al. 2014). In some areas of sympatry, little overlap exists between
4730 Barred and Spotted Owl home ranges, which is indicative of competitive exclusion of Spotted Owls by
4731 Barred Owls (Hamer et al. 2007, Singleton et al. 2010). However, Wiens et al. (2014) found overlap
4732 between the two species with adjacent territories in western Oregon to be 81%, with most space
4733 sharing in the foraging areas outside of the core area use.

4734 Barred Owls are opportunistic hunters that consume a wide array of prey, including small mammals
4735 ranging from rabbits to bats, small to medium sized birds, amphibians, reptiles, fish, and invertebrates;
4736 however, mammals make up a majority of prey items (Hamer et al. 2001, Mazur and James 2000),
4737 making them more of a generalist than Spotted Owls in their selection of prey. Hamer et al. (2007)
4738 measured a diet overlap by biomass of 76% between Spotted and Barred Owls in a region of sympatry in
4739 the Cascades of Washington. Wiens et al. (2014) found dietary overlap by biomass between the two
4740 species to be moderate (41%) with Northern flying squirrel, woodrat and lagomorph species the primary

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prey for both (84% of Northern Spotted Owl diet and 49% of Barred Owl diet). Both studies suggest competition for food resources between the two species.

Prey species composition and density drive habitat selection and home range size for both owl species; however, Spotted Owls are more sensitive to fluctuations in prey abundance and availability than Barred Owls due to their more limited number of preferred prey species (Bond et al. 2013, Franklin et al. 2000, Hamer et al. 2007, Meyer et al. 1998, Thomas et al. 1990, Ward 1990, Zabel et al. 1995, Zabel et al. 2003, Wiens et al. 2014). The narrow range of prey selected by Spotted Owls contributes to the need for much larger home ranges in comparison to Barred Owls.

Impacts of Barred Owls on Spotted Owls

Data is lacking to adequately assess Barred Owl abundance in western North America. However, Northern Spotted Owl populations are declining throughout most of their range. The USFWS holds periodic workshops with Northern Spotted Owl researchers to assess population parameters, such as abundance, trend and survival (USFWS 2013). These workshops have resulted in four published and one unpublished meta-analyses since 1994 (Burnham et al. 1994, 1996, Franklin et al. 1999, Anthony et al. 2006, and Forsman et al. 2011). These analyses show that in areas where Barred Owls are present, the decline in Northern Spotted Owl abundance has been steeper than where the Barred Owl was absent. Declines were more prevalent where Barred Owls density was greatest. In addition, analyses determined that Northern Spotted Owl adult survival declined in a majority of the study areas in Washington, Oregon, and California where Barred Owls were present, with a more gradual decline in California sites (Forsman et al. 2011). The relatively lower rate of decline in California may be attributable to the relatively more recent Barred Owl expansion into California. The presence of Barred Owls in or near Spotted Owl territories appears to be impacting the abundance, fecundity, and survival of Spotted Owls (Olson et al. 2004, Forsman et al. 2011). Wiens et al. (2014) found annual survival for Northern Spotted Owl in western Oregon lower (0.81, SE=0.05) than that of Barred Owl (0.92, SE=0.04), with a strong positive relationship on survival to old forests (>120 years) for both species. Northern Spotted Owl reproduction increased linearly with increasing distance from Barred Owl territory centers, and all Northern Spotted Owl nests failed when within 1.5 km (0.93 miles) of a Barred Owl nest (Wiens et al. 2014).

The expansion of the Barred Owl range into that of the Spotted Owl has been documented mainly through incidental detections during Spotted Owl surveys. Based on these detections, numerous researchers have reported that Barred Owl numbers quickly increase after a short period of slow increase once they arrive in a new area (USFWS 2013). In the Oregon Cascades, Barred Owl detections increased from one initial detection in 1979 to over 700 detections by 1998 (Kelly 2001). Barred Owls can also quickly outnumber Spotted Owls; in the Northern Cascades in Washington, Barred Owl abundance was twice that of Spotted Owls within 17 years of the first detection (Hamer et al. 1988). In the range of the Spotted Owl, the density of Barred Owls is greatest in the north, where they have been present the longest (British Columbia and Washington), and fewer detections have been made in the southern edge of the range (California) where they have been present for a shorter duration (USFWS

Comment [EMG31]: FWS does not host these workshops (although we do participate). USGS and USFS are the lead agencies for these.

Comment [EMG32]: Burnham et al. 1996 is the published version of the 1994 report. The only unpublished report was Franklin et al. 1999.

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4779 2013). Despite this general north-south gradient in the density of Barred Owls, Forsman et al. (2011)
4780 provide strong evidence of increasing Barred Owl populations throughout the range of the Northern
4781 Spotted Owl and California Spotted Owl.

4782 Barred Owl presence has also been determined to be negatively associated with Spotted Owl occupancy
4783 throughout the range of the Northern Spotted Owl (Olson et al. 2005, Kroll et al. 2010, Forsman et al.
4784 2011, Sovern et al. 2014). Studies have shown that Barred Owl presence influences whether Spotted
4785 Owls occupy a territory (Kelly 2001, Pearson and Livezey 2003, Gremel 2005, Sovern et al. 2014). In
4786 Olympic National Park, an area with historic Northern Spotted Owl territories, occupancy of Spotted
4787 Owls declined by almost 20 percent as Barred Owl presence increased by 15 percent between 1992 and
4788 2003 (Gremel 2005). It has also been determined that Spotted Owls will move activities away from areas
4789 with Barred Owl presence even if they do not move their territory (Kelly 2001, Gremel 2005). Within the
4790 Hoopa Valley Indian Reservation (Humboldt County, California), Barred Owls were detected in over 85%
4791 of all historic Northern Spotted Owl territories between 2009 and 2014 (Higley and Mendia 2013).
4792 Northern Spotted Owl occupancy in the Hoopa study area started a steep decline in 2004, in concert
4793 with a boom in Barred Owl occupancy; and in 2013, Northern Spotted Owl occupancy was down to
4794 0.595 while Barred Owl occupancy increased to 0.838 (95% CI) (Higley and Mendia 2013).

4795 For the Willow Creek Study Area (part of the NWC study area), Franklin et al. (2015) reported a mean λ
4796 of 0.975 (1985-2014; SE 0.012), indicating a decline in the Northern Spotted Owl population for this
4797 area. The mean survival rate was 0.848 (1985-2014; SE 0.009). Survival rate was thought to be
4798 negatively influenced by the presence of Barred Owl. The Willow Creek Study Area has experienced a
4799 dramatic increase in Barred Owl detections, from one barred owl site in 1991 to 22 in 2014 (Franklin et
4800 a. 2015). Spotted Owl territories having Barred Owl detections ranged between 0-37 within the same
4801 timeframe (Franklin et al. 2015).

4802 When Barred Owls were first detected in a Northern Spotted Owl territory on Green Diamond Resource
4803 Company land, Humboldt County, Northern Spotted Owls no longer responded to taped playback calls,
4804 demonstrating they were either absent from the territory or not responsive (Diller 2012). In 2014, there
4805 were 268 Barred Owl detections on Green Diamond Resource Company land, representing an estimated
4806 65 territories, and demonstrates a 76% increase in detections from 2011-2014 (GDRC 2015). Forty-eight
4807 of the 65 territories were within the density study area (GDRC 2015).

4808 Barred Owl removal experiments were conducted on Green Diamond Resource Company land to assess
4809 the impacts Barred Owls were having on Northern Spotted Owl presence (Diller 2012 and GDRC 2015).
4810 When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within
4811 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that
4812 some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to
4813 Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed
4814 (Diller 2012).

4815 During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley
4816 Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97%

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adulthood, 92.9% female, 65.3% male), with at least one Barred Owl removed from 28 historic Northern Spotted Owl territories, and >2 removed from 21 Northern Spotted Owl territories (Higley 2014). Spotted Owl occupancy since the removal has occurred has not yet been reported.

Spotted Owls will reduce their calls or not call at all if Barred Owls are in the vicinity (Cozier et al. 2006, Diller 2012, Sovern et al. 2014), making it more difficult to detect Spotted Owls if Barred Owls are present. Thus, standard surveys might result in occupancy status being misclassified (e.g., a false-negative survey -- designating sites as unoccupied by Spotted Owls when in reality Spotted Owls are present but are not vocalizing). Beyond land management implications (e.g., timber harvest or not), this behavior shift by the Spotted Owl may also have implications for reproduction because calls are used to defend a territory and locate mates, and during pair bonding and prey delivery to the nest site (USFWS 2013).

The ecology of Barred Owls gives them a competitive advantage over Spotted Owls regarding reproductive success and productivity (Courtney et al. 2004, USFWS 2013). Barred Owls have larger clutches (1 to 5 chicks) than Spotted Owls (1 to 3 chicks), and Barred Owls may produce up to three clutches per season, both of which may lead to higher productivity (Gutiérrez et al. 1995, Mazur et al. 2000, Gutiérrez et al. 2007). Some studies have found that Spotted Owls often do not breed every year, and that productivity varies from year to year (Forsman et al. 1984, Mazur et al. 2000, Rosenberg et al. 2003, Forsman et al. 2011).

The literature suggests that Barred Owls are displacing Northern Spotted Owls from their territories, and Spotted Owls are forced into lower quality breeding and foraging habitat (USFWS 2013, Sovern et al. 2014). In addition, detecting Spotted Owls during surveys is likely hindered because Spotted Owls vocalize less often when Barred Owls are nearby (Crozier et al. 2006). Displacement and reduced vocalizations are thought to negatively impact Spotted Owl productivity (Forsman et al. 2011). As discussed previously, Barred Owls are prey generalists and Spotted Owls are prey specialists; a factor that may play into reproductive success (USFWS 2013).

Barred Owls are aggressive toward Spotted Owls, and have attacked Spotted Owls on occasion. Courtney et al. (2004) reported several instances where Spotted Owls were attacked by Barred Owls, and where surveyors were attacked by Barred Owls while playing Spotted Owl calls. Leskiw and Gutiérrez (1998) suspected that a Barred Owl killed and partially consumed a Spotted Owl. Johnston (2002, as cited by Courtney et al. 2004) presented evidence that a Barred Owl likely killed a juvenile Spotted Owl. It is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities were due to territorial aggression (USFWS 2013). By comparison, instances reported of Spotted Owl aggression toward Barred Owls are few (George and Lechleitner 1999, A. Ellingson, pers. comm, P. Loschl, pers. comm as cited in Courtney et al. 2004).

Lewicki et al. (2015) sampled blood from Northern Spotted Owls and western Barred Owls throughout Siskiyou, Trinity, Humboldt, and Mendocino counties in an attempt to evaluate parasite dynamics and the related impacts of Barred Owl range expansion on spotted owls. Specific results related to parasite prevalence are noted within the Disease section of this report below. The study suggests that parasite

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4855 dynamics in Northern Spotted Owls are not solely influenced by the presence or absence of Barred
4856 Owls, but that more research is needed to assess roles of additional factors relating invasion to
4857 host/parasite dynamics (Lewicki et al. 2015).

4858 The literature suggests that Barred Owls have impacted Northern Spotted Owls in a variety of ways,
4859 including reduced survival and occupancy, displacement, reduced detection rates, and predation. In the
4860 northern portion of the Northern Spotted Owl range, where Barred Owls have existed longer and are
4861 more densely distributed, the realized negative impacts are severe. In California, where Barred Owl
4862 occurrences are relatively recent, the negative impacts are less severe at this point. However, in
4863 portions of the northern California range where Barred Owls have become more common in recent
4864 years, impacts to Northern Spotted Owls, including displacement and declines in occupancy and survival
4865 rates, have been observed.

4866 **Disease**

4867 The 2011 Revised Recovery Plan (USFWS 2011a) states, “It is unknown whether avian diseases such as
4868 West Nile virus (WNV), avian flu, or avian malaria... will significantly affect Spotted Owls.” Likewise,
4869 disease occurrence in Spotted Owls is likely under-reported because Spotted Owls tend to inhabit
4870 remote areas and, therefore, there is a small likelihood of carcass recovery for testing (K. Rogers,
4871 personal communication, September 25, 2014).

4872 In California, two studies have investigated the prevalence of WNV in raptor populations (Hull et al.
4873 2006, Hull et al. 2010). In migrating and wintering hawks, Hull et al. (2006) found of the 271 red-tailed
4874 hawks, 19 red-shouldered hawks, and 30 Cooper’s hawks tested, WNV antibodies were present in 5-58
4875 percent. However, no individuals that tested positive demonstrated any visible signs of illness.
4876 Conversely, WNV antibodies were not detected in 62 Northern goshawks, 209 Spotted Owls, and 22
4877 great gray owls sampled in the Sierra Nevada, suggesting low prevalence or high mortality in these
4878 species (Hull et al. 2010). Only one recent case of WNV infection was reported in a dead California
4879 Spotted Owl in 2013 from the Sierra Nevada (K. Rogers, personal communication, September 25, 2014).

4880 Research conducted elsewhere in North America, suggests WNV infection causes morbidity and
4881 mortality in several species of raptors. In Colorado, WNV infection was highest in red-tailed hawks and
4882 great-horned owls (compared to other raptor species) admitted to wildlife rehabilitation centers; clinical
4883 signs were variable and included emaciation, weakness, and inability to perch, fly, or stand (Saito et al.
4884 2007). Additionally, 40 of 56 dead raptors, evaluated for WNV, were positive; histological lesions most
4885 often included encephalitis and myocarditis (Saito et al. 2007). In Georgia, 40 out of 346 raptors tested
4886 for WNV were positive, including 4 Barred Owls, one great horned owl, and four eastern screech owls
4887 (Ellis et al. 2007). All 40 cases occurred during summer and late fall (Ellis et al. 2007), when mosquito
4888 activity is most common. Gancz et al. (2004) investigated an outbreak of WNV in several species of
4889 captive owls in Ontario, Canada, including one Spotted Owl and eight Barred Owls. Owl species with
4890 more northerly breeding ranges (e.g., snowy owl, great gray owl) showed higher rates of infection than
4891 more southerly breeding species (e.g., barn owl, eastern screech owl) (Gancz et al. 2004). WNV infection
4892 in these captive birds was found to coincide with a summer louse fly infestation, suggesting bites from

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4893 the louse flies aided in WNV transmission (Gancz et al. 2004). Additionally, there is evidence that raptors
4894 can become infected with WNV after feeding on infected prey (Nemeth et al 2006). WNV infection is
4895 routinely identified in squirrels (Family: Sciuridae) (Padgett et al. 2007), as well as jays and other
4896 songbirds (Hull et al. 2010; Wheeler et al. 2009) in California; the range of these species may overlap
4897 with that of Northern Spotted Owls, possibly posing an additional infection risk.

4898 Other diseases that may impact Spotted Owls are largely unknown at this time. There are no known
4899 studies or cases of mortality caused by avian (flu) influenza in Spotted Owls. According to Rogers pers
4900 comm. (2014), prevalence of avian influenza in the spotted population is expected to be low since the
4901 disease is primarily carried by waterfowl and shorebirds, two groups that have low interaction with
4902 Spotted Owls. In addition, little information is available on the prevalence of avian malaria or
4903 Leucocytozoonosis (both blood parasites) in Spotted Owls. Significant mortality due to avian malaria or
4904 Leucocytozoonosis is rarely reported in avian species (K. Rogers, personal communication, September
4905 25, 2014), with the exception of island endemics or birds in captive situations and most infected birds
4906 seem to recover or may have chronic infections. Impacts of parasitic infection to Northern Spotted Owl
4907 survival are also unknown. However, Martinez et al. (2010), documented lowered survival of wild-
4908 breeding female blue tits (*Cyanistes caeruleus*) in Spain infected with *Haemoproteus* parasites
4909 (*Haemoproteus* and *Leucocytozoon* spp.).

4910 There are a handful of studies that have documented blood and intestinal parasites in owl species. Ishak
4911 et al. (2008) tested 111 Spotted Owls, and 44 Barred Owls, and 387 owls of nine other species for
4912 Leucocytozoon, Plasmodium, and Haemoproteus spp. (haemosporidian blood parasites). The study
4913 found both California and Northern Spotted Owls carried the greatest number of Leucocytozoon
4914 parasite lineages, California Spotted Owls had a higher prevalence of infection with more multiple
4915 infections than Northern Spotted Owl, and Barred Owls along the coast had lower rate of infection
4916 (15%) than Northern Spotted Owls (52%) and California Spotted Owls (79%). They suggested that the
4917 greater infection load of Spotted Owls compared to Barred Owls may favor the later in competitive
4918 interactions. Interestingly, Ishak et al (2008) documented the first ever case of Plasmodium infection in a
4919 Northern Spotted Owl. Gutiérrez (1989) tested 105 Spotted Owls (seven populations and all subspecies)
4920 for hematozoa (a blood parasite) and found all to be infected with at least one hematozoan. This study
4921 suggested that the owls large home range, spanning various forest types, the time spent caring for and
4922 provisioning young, and their long life span make this species more susceptible to higher rate of
4923 infection compared to other bird species (Gutiérrez1989). From 2008 to 2012 blood samples were
4924 analyzed from Northern Spotted Owls (n=98) and western Barred Owls (n=49) throughout Siskiyou,
4925 Trinity, Humboldt, and Mendocino counties and tested for blood parasite loads (Lewicki et al. 2015). For
4926 comparison, blood samples were also analyzed from eastern Barred Owls (n=135) housed in wildlife
4927 rehabilitation centers throughout their historic range. Lewicki et al. (2015) found *Haemoproteus* spp.
4928 infection prevalence higher in Northern Spotted Owl (76.5%) than western Barred Owl (30.6%), and
4929 highest in eastern Barred Owl (88.1%), and infection intensity was nearly 100 times greater in Northern
4930 Spotted Owl than western Barred Owl. The study did not directly evaluate the impacts of blood parasite
4931 infections on the owl species assessed (Lewicki et al. 2015).

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In Oregon, Hoberg et al. (1993) reported enteric coccidia (intestinal parasite) in a juvenile female Northern Spotted Owl. The presence of the parasite did not appear to contribute to the juvenile Spotted Owl's death; however, death has been attributed to this type of parasite in other raptor species (Hoberg et al. 1993). In this case study, transmission was thought to be through consumption of infected small mammal prey (e.g., mice, squirrels, woodrats). Trichomonosis is a concern for Spotted Owls if they consume Columbids infected with the protozoan parasite, *Trichomonas gallinae*, where species ranges overlap. The Department's Wildlife Investigation Lab documented two cases of Trichomonosis in California Spotted Owl in 2012, two cases in Northern Spotted Owl in 2014 from the Coastal Mountain Range, north of San Francisco Bay, and one in a great gray owl in 2006 and in 2007 (K. Rogers, personal communication, September 25, 2014).

In northwestern California, Young et al. (1993) found Hippoboscids on 62 of the 382 Northern Spotted Owls captured over five years between April and September, with higher prevalence in adults than juveniles. The flies were more abundant in years when fall temperatures were high, winter precipitation was low, and summer temperatures were low, suggesting fly abundance is climate dependent. Consequently, the frequency of Hippoboscids in the Northern Spotted Owls population may vary in intensity as climate changes (Young et al. 1993).

To address the shortfall of information on disease impacts to Spotted Owls, Recovery Action 17 of the 2011 Recovery Plan is, "Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, Plasmodium spp.) and address as necessary" (USFWS 2011a). In addition, the Department's Wildlife Investigation Lab is currently conducting a raptor disease and contaminant surveillance study that will help determine disease occurrence and contaminant exposure in raptor populations statewide, including both Northern and California Spotted Owls. This study will include targeted surveillance for a wide array of diseases and contaminants such as, WNV, mange, Avian Trichomonosis, Avian Chlamydiosis, and Avian Herpesvirus, AR and lead poisoning.

Contaminants

Northern Spotted Owls feed on a variety of prey species, but mainly small mammals make up the bulk of their diet. Consequently, the main contaminant threat to the owls is anticoagulant rodenticide poisoning. The anticoagulant rodenticides (ARs) are grouped into first-generation compounds (diphacinone, chlorophacinone and warfarin), requiring several doses to target species before death occurs, and second-generation ARs (SGARs; e.g., bromadiolone, brodifacoum, difenacoum and difethalone), requiring only a single dose. Second generation ARs are more acutely toxic and persist in tissues and in the environment (Gabriel et al. 2013).

Numerous field monitoring studies on other raptor and owl species indicate lethal and sublethal impacts of AR exposure (Mendenhall and Pank 1980, Stone et al. 2003, Walker et al. 2008, Albert et al. 2009, Murray 2011, Thomas et al. 2011, Christensen et al. 2012, Sánchez-Barbudo et al. 2012). In California, Lima and Salmon (2010) analyzed tissues from 96 raptors of 10 species brought to wildlife rehabilitation centers in San Diego and the Central Valley, and found that 69% (Central Valley) to 92% (San Diego) had been exposed to anticoagulant rodenticides. In Massachusetts, Murray (2011) tested 161 wild Red-

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4970 tailed Hawks, Barred Owls, Eastern Screech Owls (*Megascops asio*), and Great Horned Owls and found
4971 86 percent with ARs in liver tissue, of which 99 percent was brodifacoum, a SGAR. Another study in New
4972 York found ARs present in 49 percent of wild raptors tested (n=265; 12 species), most prevalent in Great
4973 Horned Owls (43/53; 81%) and less prevalent in Barred Owls (3/13; 23%), with SGARs (brodifacoum and
4974 bromadiolone) being the most frequently detected (Stone et al. 2003). Nine of the 53 Great Horned
4975 Owls and one of the 13 Barred Owls died in this study, revealing a mortality rate of 17 percent and 8
4976 percent, respectively (Stone et al. 2003).

4977 In addition to the field monitoring that demonstrates widespread exposure of raptor/owl species to ARs,
4978 investigations of wildlife mortality incidents show that raptors comprise two-thirds of the anticoagulant-
4979 related wildlife mortalities (Department's Wildlife Investigation Lab files). These incidents are most likely
4980 to be reported in more populated areas, but it is reasonable to assume that any area where ARs are
4981 used for outdoor rodent control would share a similar pattern. The Department's Wildlife Investigation
4982 Lab documented several recent cases of AR poisoning for the California Spotted Owl (K. Rogers, personal
4983 communication, September 25, 2014); two cases in 2013, and two in 2014. However, at this time it is
4984 unknown how widespread morbidity and mortality is for the spotted owl population in California. As
4985 mentioned above, the Wildlife Investigation Lab is currently conducting a statewide raptor disease and
4986 contaminant surveillance study that will target AR occurrence in raptor populations to help shed light on
4987 the extent of this threat.

4988 Few laboratory studies have been conducted that test impacts of ARs on raptors, and no known studies
4989 have evaluated impacts on spotted owls. In a laboratory study by Mendenhall and Pank (1980), three
4990 species of captive owls fed mice or rats killed with the ARs bromadiolone, brodifacoum, or diphacinone
4991 (SGARs) died of hemorrhaging, those fed mice or rats killed with difenacoum (SGAR) displayed sublethal
4992 hemorrhaging, and those fed mice or rats killed with fumarin or chlorophacinone (1st generation ARs)
4993 displayed no signs of illness. Eastern Screech Owls were fed diphacinone for 7 days in a laboratory
4994 setting and monitored for 21-days post exposure (Rattner et al. 2013). This study found that toxicity
4995 appeared quickly upon exposure to lethal levels, but returned rapidly to normal in most owls after
4996 exposure was terminated (Rattner et al. 2013).

4997 Bond et al. (2013), notes the use of rodenticides (prevents damage to young trees from rodents
4998 browsing) or herbicides (suppresses shrubs to allow growth of trees) in burned forests and the potential
4999 threat of these substances to Spotted Owls. The use of herbicides and rodenticides may reduce the prey
5000 habitat and abundance for Spotted Owls, however it is unlikely the activity would be a major source of
5001 rodenticide exposure for owls because the type of poison used are generally 1st generation
5002 anticoagulant rodenticides, which are not as persistent or toxic in their target species (S. McMillin,
5003 personal communication, September 25, 2014).

5004 In illegal marijuana grows, widespread in the Northern Spotted Owl range, growers typically apply
5005 second generation AR at the base of plants to prevent small mammals from damaging the crop
5006 (Thompson et al. 2013, Gabriel et al 2013). These 2nd generation rodenticides present a risk to predators
5007 of small mammals, such as the Northern Spotted Owl, because this type of rodenticide is more acutely
5008 toxic, and persists in tissues and in the environment (Gabriel et al. 2013).

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The fisher is a species whose range and prey base overlaps with the Northern Spotted Owl (Zielinski et al. 1999, Zielinski et al. 2004), thus, the impacts of rodenticides in fisher may also be an impact to Northern Spotted Owl. Thompson et al. (2013) studied impacts of ARs to fishers in the southern Sierra Nevada and found impacts of ARs in association with illegal marijuana grows significant. Toxicants found at grow sites within the study area included brodifacoum and bromadiolone (SGARs), carbofuran (a pesticide currently banned in the United States), and malathion (an insecticide). Thirty-nine out of 46 fisher carcasses recovered (88%) tested positive for one of more AR compound with brodifacoum being the most common (Thompson et al. 2013). Another fisher study in California's Sierra Nevada found 79 percent of fisher carcasses (n=58) tested were exposed to ARs, and of that, 96 percent were exposed to SGAR compounds (Gabriel et al. 2013). Given these results, and the presumed extent of illegal marijuana grows in California (Gabriel et al. 2013, Thompson et al. 2013), it is likely that exposure to AR prevalence is widespread and is impacting Northern Spotted Owls in California to some extent. However, the effects and prevalence of poisoning events on overall fitness (e.g., survival and fecundity) remains unknown.

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytophthora ramorum*) which infects a variety of species. It is particularly lethal to tanoaks (*Lithocarpus densiflorus*) and several species of true oaks (*Quercus* spp.). In other species it may cause dead bark, leaf blight, and twig dieback (Shaw 2007, USFWS 2011a), and some hosts may be asymptomatic. Nearly all tree species in mixed evergreen and redwood-tanoak forest types may be hosts (Davidson et al. 2003, Garbelotto et al. 2003). According to Goheen et al. (2006),

"The pathogen has a wide host range including Douglas-fir, grand fir, coast redwood, and many other tree and shrub species common in Oregon and Washington forests. Tree mortality, branch and shoot dieback, and leaf spots result from infection depending on host species and location. *Phytophthora ramorum* spreads aerially by wind and wind-driven rain and moves within forest canopies and tree tops to stems and shrubs and from understory shrubs to overstory trees. The pathogen survives in infected plant material, litter, soil, and water. It is moved long distances in nursery stock... State and Federal personnel regularly survey forests and nurseries in the Pacific Northwest to detect the disease."

In 1995, sudden oak death was discovered in California within Mill Valley (Marin County), and has since spread across multiple coastal counties impacting coastal live oaks and tanoak forests within (Tietje et al. 2005). According to recent submission to the GIS tool "OakMapper", confirmed locations of *P. ramorum* in California range from the coastal ranges in Monterey County and north up through portions of Humboldt County (California Oak Mortality Task Force 2015). Many studies have documented the widespread damage and mortality of oak-tanoaks coastal woodlands from Humboldt to Monterey counties (Rizzo and Garbelotto 2003, McPherson et al. 2005, Goheen et al. 2006, Cobb et al. 2009, Cobb et al. 2012). Shaw (2007) indicated that the disease in California is likely linked to coastal climates that are typically warmer and wetter than more inland forest types. There is large-scale concern regarding the impacts of this disease on forest structure and composition in California, and the associated impacts to wildlife species that inhabit these forests.

Comment [A33]: Note to external reviewers: A publication is in the works to assess the potential impacts of ARs associated with marijuana plants to spotted owls, using barred owls as a surrogate. An abstract regarding this work, noted that the study found 40% of all Barred Owls tested were exposed to ARs in suitable NSO habitat within managed timberland in NW CA. The full analysis and result write-up are underway. Information from this effort will likely inform us on exposure to and impacts of ARs to owl fitness. This information will have to be added after external review, assuming it is ready prior to submission of this report to the Fish and Game Commission.

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5048 Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases
5049 quickly. Cobb et al. (2009) examined mortality caused by sudden oak death within coastal redwood
5050 forests from Sonoma to Monterey counties. Tanoaks confirmed to be infected died on average within 1-
5051 6 years, and larger trees that were close to other infected species, such as the California bay laurel
5052 (*Umbellularia californica*), were infected to a greater extent than smaller, more remote trees. Tanoaks
5053 survived longer within redwood and Douglas-fir dominated forests than in hardwood dominated stands
5054 (Cobb et al. 2009). In Marin County, McPherson et al. (2010) examined the survival of coast live oaks,
5055 black oaks (*Q. kelloggii*) and tanoaks once infected by sudden oak death. The study found that live oak
5056 and tanoak survival declined as a function of disease state. Coast live oak survival was 11.7 to 15.8 years
5057 for asymptomatic trees; 7.5 to 11.7 years for trees bleeding only; and 2.6 to 3.4 years for trees bleeding
5058 with ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010). Tanoak survival was 8.8
5059 years for asymptomatic trees; 5.9 years for trees bleeding only; and 1.7 years for trees bleeding with
5060 ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010).

5061 After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi
5062 and insects is common and impacts survival times. For example, McPherson et al. (2005) found
5063 symptomatic progression and eventual mortality of coast live oaks and black oaks due to sudden oak
5064 death followed a similar sequence: bleeding, beetle colonization, emergence of *Hyposylon thouarsianum*
5065 (another fungal infection), and then death. Here, approximately 50% of bleeding live oaks were infected
5066 by ambrosia beetles and bark beetles, or showed evidence of past beetle infestation, whereas beetles
5067 infested tanoaks with less frequency (McPherson et al. 2005).

5068 It is unlikely that the impact of sudden oak death on oak-tanoak forests will subside in the future. Brown
5069 and Allen-Diaz (2005) examined past, current and future changes of coast live oaks-bay laurel woodland
5070 structure and composition within the San Francisco Bay Area due to sudden oak death infections. There
5071 was a 2-27% loss of coast live oak basal area (m²/ha) during the study period (2002-2004), a 4-55% loss
5072 in the recent past (5-10 years prior to 2002) through 2004, and a projected 15-69% coast live oak basal
5073 area loss in the future, with a total stand basal area was predicted to decrease up to 42% within the next
5074 5 years (Brown and Allen-Diaz 2005). Meentemeyer et al. (2009) predicted that with no control
5075 measures, sudden oak death will increase by 10-fold by 2030, particularly along the coast north of San
5076 Francisco. The model suggests that wet weather conditions exacerbated by predicted change climate
5077 regimes serve to double the rate of spread in California (Meentemeyer et al. 2009). Predictive models
5078 note forests at high risk to sudden oak death in California occur in coastal forests of Santa Barbara
5079 County north through Humboldt County (Koch and Smith 2012).

5080 Oak-tanoak forests are present within the Northern Spotted Owl range in California and are an
5081 important component to owl habitat (see Habitat Section of this report). Oak and tanoak forest types
5082 and as elements within conifer forest provide habitat for the owl's main prey base, the dusky-footed
5083 woodrat, as well as other small mammals that comprise a smaller component of the owl's diet. There
5084 are no known published work evaluating the wildlife consequences of sudden oak death focus on
5085 impacts to Northern Spotted Owl habitat; however, results from these studies may inform potential or
5086 likely impacts of sudden oak death the species given what we know about owl habitat and prey needs.

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Within an infected study site in on Marin County, Temple and Tietje (2005) found coarse woody debris, a habitat component important for many small mammals, was 70 times higher than on an uninfected plot in Sonoma County, a difference supposedly due to sudden oak death-induced coarse woody debris generation. Within San Luis Obispo County, an area where sudden oak death has a low prevalence, areas in “high-risk” woodlands (i.e., those with species composition thought to be most impacted by sudden oak death) small mammals, including the dusky-footed woodrat, were more abundant (Temple et al. 2005, Temple and Tietje 2005). The difference in species abundance between the sites is likely inherent, the authors’ link to sudden oak death impacts of the comparison is unclear. However, these studies speculate that California bay laurel may replace coast live oak trees in the forest canopy. While having ecological importance, California bay laurel is relatively less productive than oaks as a wildlife habitat component.

Only one study has provided any direct link to Spotted Owl occupancy and habitat impacts due to sudden oak death. Within Big Sur forests of California, Holland et al. (2009) indicated that California Spotted Owl were more likely to occur in forests with greater amount of tree mortality, suggesting sudden oak death could benefit owls in the short-term by generating coarse woody debris (e.g., downed logs and branches), key habitat features for the owl’s prey resources. However, over the long-term, coarse woody debris and snags will decay and the supply will diminish thus prey resources may decrease and thereby impacting habitat suitability for the owls.

More generally, several studies indicate an impact on small mammal populations associated with sudden oak death infestations within coastal forests, but do not provide a link between Spotted Owl occupancy. Several studies suggested that that woodrats and mice (*Peromyscus* spp.) may benefit from immediate changes in habitat features (e.g., increase in coarse woody debris, increased shrub cover) within infected areas; however long-term abundance is less certain in the face of continued sudden oak death infection (Apigian et al. 2005, Temple and Tietje 2005).

The 2011 Northern Spotted Owl Recovery Plan (USFWS 2011a) notes this disease as a potential threat “due to its potential impact on forest dynamics and alteration of key prey and Spotted Owl habitat components (e.g., hardwood trees, canopy closure, and nest tree mortality)... especially in the southern portion of the Spotted Owl’s range (Courtney et al. 2004).” However, the USFWS (2011a) asserted that the extent of the impact of sudden oak death to owl habitat, prey species, and occupancy has not been thoroughly assessed. To address the shortfall of information, Recovery Action 17 of the 2011 Recovery Plan is to “Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, *Plasmodium* spp.) and address as necessary” (USFWS 2011a). Monitoring techniques have been developed and may consist of regular aerial and ground surveys to assess rate of sudden oak death infection within oak-tanoak forest communities (Mai et al. 2005). However, such monitoring will detect spread well after a local invasion is established. Early detection techniques, such as eDNA sampling, may allow quicker intervention, but the efficacy of the various methods (Cobb et al 2013) still needs thorough evaluation.

Predation

The 2011 Revised Recovery Plan (USFWS 2011a) states,

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5125 “Known predators of Spotted Owls are limited to great horned owls (Forsman et al. 1984), and,
5126 possibly, barred owls (Leskiw and Gutiérrez 1998). Other suspected predators include northern
5127 goshawks, red-tailed hawks, and other raptors (Courtney et al.2004). Occasional predation of
5128 Spotted Owls by these raptors is not considered to be a threat to Spotted Owl populations, so
5129 no criteria or actions are identified.”

5130 No new information has been generated since this statement was made, and therefore, the threat of
5131 predation to Northern Spotted Owls remains negligible.

5132 **Recreational Activities**

5133 Natural stress events (predator interactions, precipitous weather, disease, care of young), or
5134 anthropogenic stress events (vehicle traffic and noise, hikers) can impact species on multiple levels. This
5135 may include physiological impacts such as suppressed reproduction and growth (REFS), or behavioral
5136 responses such as avoidance (e.g., vocalizations and flushing).

5137 Collecting and analyzing fecal samples has been shown to be effective at detecting stress hormone
5138 production (e.g., glucocorticoids) in owls (Wasser and Hunt 2005). By employing this methodology, a
5139 study conducted in the Shasta Trinity and Mendocino National Forests, California, found Northern
5140 Spotted Owls exhibit more stress when exposed to motorcycle activities, and exhibit lower reproductive
5141 success when exposed to busy roads (Hayward et al. 2014). Wasser et al. (1997) collected fecal samples
5142 from wild Northern Spotted Owl in Washington to measures stress hormone production in relation to
5143 timber activities (e.g., logging roads timber management). Males showed a more prominent increase in
5144 corticosterone production when the disturbance occurred with 0.41 km (0.25 miles) of the home range
5145 center, and in males whose home ranges were close to clear-cut (vs. selective logging).

5146 Presence of hikers has been shown to alter owl behavior at roosting and nesting sites. Swarthout and
5147 Steidl (2001) found that juvenile and adult Mexican Spotted Owls were less likely to flush from the
5148 presence of a hiker at 212 and 224 meters, respectively, and neither juveniles nor adults were likely to
5149 alter behavior at distances 255 meter or more. At nesting territories, Mexican Spotted Owls in Utah
5150 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance
5151 with the presence of hikers (Swarthout and Steidl 2003).

5152 It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the
5153 level to which these activities may impact owl behavior, reproduction and overall survival has yet to be
5154 determined. It is unlikely anthropogenic stress events associated with recreation will impact Northern
5155 Spotted Owl reproduction and survival to any great extent, though further research is warranted.

5156 **Loss of Genetic Variation**

5157 There had previously been little evidence in the literature of loss of genetic variation and population
5158 bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across
5159 the range of the Northern Spotted Owl provides compelling evidence that a population bottleneck may
5160 have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from

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5161 352 Northern Spotted Owls from six regions across the range which included limited samples from the
5162 northern portion of the California Klamath Province.

5163 Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades)
5164 bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant
5165 evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest
5166 California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic
5167 variation and hence effective population size, do not necessarily indicate a decline in actual
5168 (demographic) population size (Funk et al. 2010) "... it is important to keep in mind that
5169 reductions in [effective population size] (detected with bottleneck tests) are different than
5170 reductions in demographic population size (detected with demographic field studies) and
5171 reductions in one of these parameters does not necessarily result in a change in the other."
5172 (Funk et al. 2010)

5173 The scientific review of the Draft Recovery Plan Recovery was able to review unpublished genetic
5174 studies from Dr. Susan Haig (Courtney et al. 2008). Using samples collected from 352 owls, the results
5175 provided some evidence that recent bottlenecks have occurred at various spatial scales within the
5176 Northern Spotted Owl range, but could not definitively link the genetic declines to recent population
5177 declines (USFWS 2011a, Courtney et al. 2008). Genetic scientists reviewing Haig's work concluded that
5178 the bottlenecks observed by Haig were likely the result of recent population declines rather than the
5179 cause of decline (Courtney et al. 2008). Specifically, Courtney et al. (2008) states,

5180 "The conclusion by Barrowclough and Coats (1985) is still appropriate here, which is that the
5181 population dynamics of the Spotted Owl likely will be more important to its short-term survival
5182 than will be its genetic makeup, regardless of the evidence for bottlenecks having occurred in
5183 the past. Our conclusions might warrant re-consideration at some future point, in the context of
5184 explicit evidence linking reductions in genetic diversity to current conditions, and current or
5185 future population performance. "

5186 Summary of Listing Factors

5187
5188 The California Endangered Species Act directs the Department to prepare this report regarding the
5189 status of the Northern Spotted Owl in California based upon the best scientific and other information
5190 available to the Department (Fish & G. Code, § 2074.6, subd. (a); Cal. Code Regs., tit. 14, § 670.1, subd.
5191 (f)). CESA's implementing regulations identify key factors that are relevant to the Department's analyses.
5192 Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that
5193 its continued existence is in serious danger or is threatened by any one or any combination of the
5194 following factors: (1) present or threatened modification or destruction of its habitat; (2)
5195 overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-
5196 related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

Comment [EMG34]: 1.4. and 6. apply to NSO.

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5197 The definitions of endangered and threatened species in the Fish and Game Code guide the
5198 Department’s scientific determination. An endangered species under CESA is one “which is in serious
5199 danger of becoming extinct throughout all, or a significant portion, of its range due to one or more
5200 causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or
5201 disease.” (Fish & G. Code, § 2062). A threatened species under CESA is one “that, although not presently
5202 threatened with extinction, is likely to become an endangered species in the foreseeable future in the
5203 absence of special protection and management efforts required by [CESA].” (*Id.*, § 2067).

5204 The Department’s summary of listing factors are summarized below:

5205 **Present or threatened modification or destruction of habitat**

5206 *Timber Harvest and Regulatory Considerations*

5207 Although the rate of nesting and roosting habitat loss has declined since the Northern Spotted Owl was
5208 listed under the federal endangered species act in 1990, assessments performed on rangewide since the
5209 implementation of the NWFP show that habitat loss is ongoing. Wildfire and other natural disturbance
5210 has been the leading cause of habitat loss on federal land and timber harvest has been the leading cause
5211 of habitat loss on nonfederal lands since 1994. Although state regulations governing timber harvest on
5212 nonfederal lands in California (i.e., California Forest Practice Rules) are the most protective state
5213 regulations in the range of the Northern Spotted Owl, losses of nesting and roosting habitat due to
5214 timber harvest in California have continued. Since 1994, 5.8% of nesting and roosting habitat on
5215 nonfederal lands in California has been removed by timber harvest.

5216 California Forest Practice Rules

5217 Minimum habitat retention requirements are identified in the Forest Practice Rules for timber harvest
5218 occurring on privately owned land in California. Definitions for the different habitat types to be retained
5219 are also included in Forest Practice Rules. Habitat Retention requirements and definitions were
5220 developed in the early 1990s and can be found in Table 20 and Appendix 2. Retention requirements
5221 were established for a combination of nesting, roosting, and foraging habitat in the area immediately
5222 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the
5223 broader home range (1.3 mile radius).

5224 The most recent research on Northern Spotted Owl habitat requirements in California and southern
5225 Oregon have demonstrated a link between owl fitness and the amount of types of habitat, structural
5226 characteristics, and spatial configuration in a home range. This requirement for habitat heterogeneity is
5227 consistent with the general approach incorporated in the Forest Practice Rules. Although study design
5228 has varied across the major research studies, some consistent patterns have arisen. In order to support
5229 productive Spotted Owl territories, a minimum amount of older forest must be retained in the core
5230 area. The definition of ‘older forest’ evaluated in studies has varied, but consistently includes late-seral
5231 forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older
5232 forest in an approximately 400 acre core area.

Comment [EMG35]: NSO populations have declined 50-80% over the past 2 decades despite implementation of the NW Forest Plan. The annual rate of decline (approximately 3.9%) is severe. Habitat on private lands has been and continues to decline. Habitat on federal lands is somewhat more secure, but faces threats from wildfire and climate change. Barred owls are having significant negative impacts on spotted owls and are present across the entire range of the NSO. As a scientist, I believe that the northern spotted owl currently is at risk of becoming extinct in all or a significant portion of its range. NSOs in California are doing somewhat better than those further north, but the most recent metaanalysis indicates that CA populations are starting to show the severe declines that were observed in the OR/WA populations in the mid 2000s. This may influence what you decide to recommend for listing for CA; however, you have more than sufficient data to make informed recommendations.

Comment [EMG36]: Each of these subheadings should start with a clear summary statement of your conclusion for this factor followed by your justification based on data. The reader should not have to go through 7 pages of text (all of which was presented earlier in the document) to determine what you concluded.

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5233 Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling
5234 cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness.
5235 Results indicate that in order to support a productive Northern Spotted Owl territory, no more than
5236 about 50% of a home range should consist of nonhabitat.

5237 The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations
5238 for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest
5239 Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls. The total acreage of
5240 recommended retention in the USFWS guidance does not differ from that found in the Forest Practice
5241 Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range
5242 must be retained in habitat. However, based on assessment of core use areas in the interior portion of
5243 the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an
5244 activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations
5245 in line with core use areas evaluated in recent work. The most significant change in the revised USFWS
5246 recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific
5247 amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for
5248 nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained
5249 near the core is consistent with the literature.

5250 A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised
5251 USFWS recommendations (see Table 22 for the interior portion of range in California) shows large
5252 discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under
5253 the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the
5254 USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
5255 This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500
5256 acres spotted owl habitat to be retained within 0.7 miles and the total of 1,336 acres to be retained
5257 within 1.3 miles of an activity center can be composed of functional foraging habitat under Forest
5258 Practice Rules, a definition that is considered low quality foraging habitat by the USFWS; therefore there
5259 is no requirement in the Forest Practice Rules for this habitat include nesting or roosting habitat under
5260 the Forest Practice Rules.

5261 Our assessment of selected activity centers shows that the habitat retention guidance in the Forest
5262 Practice Rules are not always met, indicating that harvest is impacting Northern Spotted Owl at some
5263 locations. Of the activity centers evaluated, several experienced very high acreages of harvest at both
5264 the broad home range and in the core area, which would have resulted in territories that do not meet
5265 the USFWS recommendation for take avoidance, and would have resulted in declines in survival and
5266 fitness of the local owls.

5267 Documentation of habitat type, amount, and distribution present around activity centers after THPs are
5268 implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the
5269 Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if
5270 minimum retention requirements in the Forest Practice Rules are implemented as written, there is still
5271 the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated

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5272 failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts
5273 that have occurred in recent years.

5274 The THP review and post-harvest follow-up process should ensure that the best scientific information is
5275 being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to
5276 which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a
5277 sample of activity centers indicates that it is not universally applied and that insufficient habitat has
5278 been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern
5279 Spotted Owl is likely to continue experiencing loss of habitat in California.

5280 Salvage Logging

5281 Several variables complicate the interpretation of owl response to fire, including variation in fire
5282 severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing
5283 and duration of research post-fire. Regardless, several studies have suggested that salvage logging after
5284 a fire or occurrence of extensive high severity burns likely have contributed to a decline in habitat use,
5285 occupancy, or survival of Northern Spotted Owls. Although hampered by small sample size, incidental
5286 observations have documented declines in occupancy of burned areas following salvage logging.
5287 Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction
5288 probabilities, although the impacts of salvage logging were observed only in combination with other
5289 factors.

5290 The presence of snags has been suggested as an important component of prey habitat and as perch sites
5291 for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub
5292 and herbaceous cover and number of snags, may be impacted by salvage logging.

5293 Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the
5294 fire itself, by removing important structural elements and removing important prey habitat. The
5295 available information suggests that salvage logging reduces the probability that spotted owls will use
5296 burned areas and has resulted in declines in occupancy, either through abandonment or declines in
5297 survival.

5298 *Wildfire*

5299 Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and
5300 wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994,
5301 after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to
5302 wildfire, and most of this loss has occurred in the Klamath Province.

5303 The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to
5304 use burned areas extensively, although nesting and roosting general occurred only in unburned or low-
5305 severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by
5306 California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in

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5307 burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some
5308 evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

5309 Conversely, Northern Spotted Owls in southern Oregon were shown to have declines in occupancy
5310 following fire. These declines resulted from both high extinction rates in burned areas and low
5311 colonization rates.

5312 Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to
5313 experience declines in survival. Food limitation in burned areas may have been a factor in declining
5314 survival rates. These observed declines in southern Oregon may be confounded by the occurrence of
5315 post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl
5316 subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in
5317 the year following fire; these owls were not tracked to investigate potential longer-term effects.

5318 Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or
5319 areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance
5320 for foraging.

5321 The available information suggests that wildfires can have positive effects on Northern Spotted Owls
5322 when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without
5323 removing important nesting and roosting habitat components at the territory scale. However,
5324 uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating
5325 required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed
5326 in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be
5327 used as a management tool.

5328 Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California
5329 included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades,
5330 fires have become more frequent and average fire size has increased. In some cases fires have also
5331 burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry
5332 and hot conditions). Because climate change will likely increase the likelihood of conditions that support
5333 fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

5334 Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue
5335 experiencing loss of habitat in California.

5336 *Climate Change Impacts to Forest Composition and Structure*

5337 Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate
5338 projection scenarios specific to California, the most notable response to increase temperature was a
5339 shift from conifer-dominated forests (e.g., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g.,
5340 Douglas fir-tan oak) in the northern half of the state), expansion of conifer forests into the northeast
5341 portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine
5342 forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-

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tan oak forests, and advancement of conifer-dominated forests (e.g., redwood and closed-cone pine forests) along the north-central coast. Tree productivity along California’s north-central coastal and at high elevation forests may increase in response to increased growing season temperatures; however, reductions in summer fog in concert with increased temperatures may reduce productivity of redwood forests along the coast. In addition, the literature suggests that climate change variables will increase the severity and frequency of wildfires within the Northern Spotted Owl range.

Although climate projection models have uncertainties built-in, it is apparent from the literature that forests within California will likely experience some level of elevational and latitudinal shifts, changes in species composition, and alterations in fire regimes. For the Northern Spotted Owl, who has a heavy reliance on specific forest structure components and tree species composition, and associated prey habitat and abundance, implications of such forest shifts and fire regime changes may prove unfavorable to the species over time. During long-term landscape planning related to Northern Spotted Owls and their habitat, potential climate change impacts should be analyzed and incorporated.

Other Mechanisms of Habitat Loss

Sudden Oak Death

Sudden oak death syndrome is recognized as a potential threat to Northern Spotted Owls due to impacts on forest structure and composition, and consequently alteration of prey habitat and abundance. The disease is particularly lethal to tanoaks and several species of true oaks. Confirmed locations of sudden oak death in California range from the coastal ranges in Monterey County and north up through portions of Humboldt County. Portions of California coastal forests at a high risk of infection have been identified in Santa Barbara County north through Humboldt County.

Predictive modeling studies indicate that the disease is projected to increase 10-fold by 2030 in California, which could be exacerbated by wetter weather conditions on the coast predicted by climate change models. Given this, there is concern over the potential impact of sudden oak death in California to Northern Spotted Owls in the future. For instance, oak-tanoak forests support the dusky-footed woodrat, one of the owl’s main prey species, as well as other small mammals that comprise a smaller component of the diet. If abundance of prey is altered within the range of the Northern Spotted Owl due to decreases in oak-tanoak forests, negative impacts to owls will likely ensue.

Though no studies have yet evaluated the consequences of sudden oak death specific to Northern Spotted Owl habitat and fitness in California, there is evidence that habitat and prey abundance will be impacted in the face of this disease, and impacts will vary spatially and temporally. The literature suggests that short-term impacts may initially provide an increase in prey habitat and abundance, and thus may lead to an increased owl occupancy rate. However, this phenomenon will likely subside when habitat conditions deteriorate over time or tree species composition changes to a point the area can no longer support key owl prey species.

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5378 The extent of sudden oak death impacts to Northern Spotted Owl habitat, prey species, and occupancy
5379 needs to be thoroughly assessed. Early detection techniques should be explored and implemented
5380 within coastal California forests so that negative impacts can be realized and remediated, if possible.

5381 Marijuana Cultivation

5382 Illegal and legal marijuana cultivation in remote forests on public and private land throughout California
5383 has been on a steady increase. Within the range of the Northern Spotted Owl, Shasta, Tehama,
5384 Humboldt, Mendocino, and Trinity counties comprise the areas known for the most marijuana
5385 cultivation in California due to the remote and rugged nature of the land, making cultivation difficult to
5386 detect, and habitat conditions favorable for growing marijuana (e.g., wetter climate, rich soils). Given
5387 the difficulties in detecting both legal marijuana cultivation sites and the lack of reporting legal
5388 cultivation sites, actual distribution and density of marijuana cultivation is likely larger and higher than
5389 represented in datasets collected to date.

5390 Activities associated with cultivation (e.g., removal of large trees, degradation of riparian habitat) may
5391 negatively impact Northern Spotted Owl habitat, though data on the extent of this impact is not well
5392 known. Areas with higher prevalence of marijuana cultivation may also contain high numbers of
5393 Northern Spotted Owl activity centers. The level of impact likely depends on several factors, including
5394 the density of cultivation sites in proximity to owl activity centers and how much owl habitat is affected
5395 and to what extent. Given that marijuana cultivation is on the rise in California, a thorough assessment
5396 of potential habitat impacts to Northern Spotted Owls should be implemented.

5397 **Abundance and Demographic Rates**

5398 Few studies have attempted to examine range-wide Northern Spotted Owl population estimates. Survey
5399 methodology and effort does not allow for reliable estimates across the range or within California, and
5400 does not effectively sample nonterritorial floater individuals. Northern Spotted Owl densities vary
5401 across the range and forest types; therefore, extrapolating the few local estimates across the range of
5402 the subspecies would result in biased estimates of abundance. The Department's Spotted Owl Database
5403 houses a cumulative tally of all historic owl observations and activity centers, and for this reason it is
5404 inappropriate to use the Dataset as a surrogate for abundance and density estimates. The increase in
5405 number of activity centers over time is more likely the result of expanded survey effort than
5406 establishment of new activity centers. In addition, across most of the Northern Spotted Owl range
5407 establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a
5408 slow process given tree species growth rate (with a possible exception on the coastal redwood forests),
5409 and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

5410 One recent study made use of the immense amount of data available on Northern Spotted Owl habitat
5411 requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity,
5412 dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the
5413 range of the owl. In addition to an evaluation of source-sink dynamics, outcomes of the model included
5414 a range-wide population size estimate, and the proportion of the population in each modeling region

Comment [EMG37]: What is your conclusion? Start with your statement and then provide your justification.

Comment [EMG38]: Don't start this section with abundance/density. These metrics have NEVER been used to assess NSO population status.

Comment [EMG39]: Start with the results of the meta-analyses. These are the most comprehensive, long term datasets available and have clearly shown population declines of 40-70% for each of the study areas over the last 25 years.

Put the Schumaker study after the demography results. Nathan's paper provides valuable information on how owls move across the landscape and where important sources and sinks may be located, but it does not assess population status.

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5415 and physiographic province noted in the 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The
5416 study estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner
5417 California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling
5418 regions. Three provinces located in California were estimated to contain over 50 percent of the range-
5419 wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a
5420 stronghold for the population. Even though the complexity of the model may limit its ability to
5421 accurately model population estimates, the results suggest that California's population of Northern
5422 Spotted Owls is an important component of the range-wide population.

5423 Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource
5424 Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for
5425 more than two decades to assess demographic parameters such as population growth, survival,
5426 fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study
5427 areas range-wide. In California, the most recent meta-analysis covering years 1985-2008 reported a
5428 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline
5429 per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the
5430 Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation
5431 study area reported a 2.3% population decline per year through 2012. When converting estimates for
5432 population change to estimates of realized population change (i.e., the proportional change in estimated
5433 population size relative to population size in the initial year of analysis) two study areas in California
5434 (Green Diamond Resource Company and Northwest California) showed estimated population declines of
5435 about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight
5436 decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary
5437 meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across
5438 the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The
5439 ongoing analysis has revealed declines in California between 32 and 55% over the study period.

5440 In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young
5441 produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged
5442 from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green
5443 Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian
5444 Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in
5445 Washington and Oregon. Although less severe than in Washington and much of Oregon, all three
5446 California study areas show declines in survival.

5447 Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in
5448 California give us information on current estimates for reproductive success (number of young fledged
5449 per monitored site) and survival, and are consistent with a continued decline within all demographic
5450 study areas in California. In the coastal portion of the Northern Spotted Owl range in California, many
5451 areas reported consistently low reproductive success from 2011-2013, including some of the lowest
5452 reproductive success rates on record in 2013 despite weather conditions that would typically support
5453 good reproductive success. This was observed on many timber company lands, tribal lands, and National

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5454 Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In
5455 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive
5456 rate since 2009.

5457 The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study
5458 areas in California reflected trends on non-federal lands because two study areas are on non-federal
5459 lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl
5460 habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal
5461 land. However, the authors also suggest that results depict an optimistic view of the overall population
5462 status of the Northern Spotted Owl on private lands because the non-federal lands included in the
5463 demographic study areas are managed for owls. Results from the demographic study areas are thought
5464 to be representative of federal lands and areas of mixed federal and private lands throughout the range
5465 of the Northern Spotted Owl because the study areas were large, distributed across a broad geographic
5466 region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

5467 Occupancy data is based on the presence or absence of owls from known sites. In order for estimates of
5468 occupancy to be valid, survey efforts must be consistent over time and the detection probability (the
5469 probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead
5470 to high variation in detection probability which can skew estimates of occupancy if not accounted for.
5471 Although an evaluation of occupancy rates has not been included in previous demographic meta-
5472 analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the
5473 number of territorial owls detected on all 11 areas was lower at the end of the study period than at the
5474 beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling
5475 for the first time. Preliminary results show that occupancy rates have declined at all three California
5476 study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on
5477 occupancy by increasing the local territory extinction rate.

5478 Occupancy has been shown to be in decline for areas outside the California demographic study areas as
5479 well. For example, the southern Cascades and interior Klamath provinces of California determined
5480 occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl
5481 declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

5482 It is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of
5483 demographic rates across the range indicate the declines in demographic parameters, including
5484 population size, have accelerated. The level of decline does not seem to be slowing even with the
5485 implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at
5486 threats leading to these declines is warranted, including reevaluation of the effectiveness or management
5487 techniques across the Northern Spotted Owl range in California.

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5488 **Predation**

5489 Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-
5490 tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The
5491 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted
5492 Owls is not a threat to the population. In the case of documented Barred Owl aggression toward
5493 Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented
5494 mortalities were due to territorial aggression. Given that predation is not considered to be a major
5495 threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly
5496 manage predation issues.

Comment [EMG40]: What is your conclusion?
“Predation is not currently a major threat to the
northern spotted owl.”

5497 **Competition**

5498 Over the last several decades, Barred Owls have gradually moved further into the range of the Northern
5499 Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been
5500 present the longest (British Columbia and Washington), with fewer detections made in the southern
5501 edge of the range (California) where they have been present for a shorter duration. Currently, Barred
5502 Owls have been documented in all portions of the Northern Spotted Owl range throughout California,
5503 though densities of Barred Owls are unknown.

Comment [EMG41]: What is your conclusion?

5504 Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to
5505 the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most
5506 important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat
5507 and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong
5508 indication that the two species can coexist over time, sharing the same habitat and prey-base, because
5509 there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and
5510 not by Barred Owls.

5511 Public workshops held by the USFWS Workshops held by USGS and USFS in conjunction with other
5512 scientists have resulted in four published and one unpublished meta-analyses since 1994 to assess
5513 population parameters, such as abundance, trend, and survival. These analyses show that in areas
5514 where Barred Owls are present, the decline in Northern Spotted Owl abundance has been steeper than
5515 where the Barred Owl was absent. Declines have been more prevalent where Barred Owls density was
5516 greatest. Northern Spotted Owl adult survival has declined in a majority of the range where Barred Owls
5517 were present, with a more gradual decline noted in California largely attributed to the relatively more
5518 recent Barred Owl expansion into this portion of the range. Presence of Barred Owls in or near Northern
5519 Spotted Owl territories is also thought to negatively impact fecundity, survival, and occupancy of
5520 Northern Spotted Owls.

Comment [EMG42]: NOT a FWS effort. The
meta-analysis are conducted by USGS and USFS.
They are also not really public workshops. While
interested people are frequently allowed to attend,
these are intensive analytical workshops conducted
by the scientists involved.

5521 Experimental studies to remove Barred Owls conducted in California demonstrated that Northern
5522 Spotted Owl occupancy decreases with Barred Owl presence and increases with Barred Owl removal,
5523 suggesting that Barred Owls are displacing Northern Spotted Owls from their territories, forcing them
5524 into lower quality breeding and foraging habitat.

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5525 Given the severity of impacts and the quick range expansion into California, Barred Owl is considered
5526 one of the major threats to Northern Spotted Owl populations in California. More research is needed to
5527 assess Northern Spotted Owl site occupancy, reproduction, and survival in the face of Barred Owl
5528 presence, including the implementation of experimental removal of Barred Owls. Resource partitioning
5529 between the two species also needs further investigations.

5530 **Disease**

Comment [EMG43]: What is your conclusion?

5531 Several studies indicate that raptors, including Spotted Owls, may be impacted at some level by disease
5532 and insect infestations (e.g., West Nile Virus, avian influenza, avian malaria, Leucocytozoonosis, fly/mite
5533 infestations). The 2011 Northern Spotted Owl Revised Recovery Plan recognizes that disease threat is
5534 unknown, but may significantly impact owls. Disease occurrence in Northern Spotted Owls is likely
5535 under-reported because owls tend to inhabit remote areas and, therefore, there is a small likelihood of
5536 carcass recovery for testing. Disease may be a significant threat to Northern Spotted Owls, but more
5537 research is needed to better understand prevalence and magnitude of impacts in owl populations in
5538 California.

5539 **Other Natural Events or Human-related Activities**

Comment [EMG44]: As with previous sections, start with your conclusion statements for each subheading.

5540 *Precipitation and Temperature Changes*

5541 Most climate projection scenarios agree that the forests in the Northern Spotted Owl's range will have
5542 wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased
5543 frequency and intensity of disturbance events. According to many climate projections, the frequency
5544 and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will
5545 increase over time. Vulnerability to disturbance, such as wildfire, disease, and insect outbreaks, is
5546 expected to increase in most forests in the Northwest and may change forest composition and structure
5547 depending on changes to climate. Climate modeling studies agree that forest wildfire occurrence and
5548 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced
5549 snowpack, earlier spring snowmelts, and longer drier summers.

Comment [EMG45]: This has the potential to have severe negative effects on NSO habitat.

5550 Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These
5551 studies indicate that winter precipitation is closely associated with a decrease in survival and
5552 recruitment; population growth was positively associated with wetter conditions during the growing
5553 season (May through October) and negatively associated with cold/wet winters and nesting seasons,
5554 and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction
5555 increased with late nesting season precipitation and decreased with warm temperatures; and owls may
5556 be more sensitive to changes in spring time climatic events.

5557 It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many
5558 climate projections forecasting steady changes in the future. Climate change studies predict future
5559 conditions that may negatively impact owls, such as wet and cold springs, more frequent and sever

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summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased frequency of severe wildfire events. Yet in some instances projected future conditions, such as increased frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other areas of the range. Looking at past precipitation and temperature trends, drying trends across most of the range coupled with warmer winters and cooler summers in the interior and cooler winters and warmer summers along the coast may play a role in both owl and prey population dynamics. More research is needed to assess the extent of these climate impacts on survival, population growth, and reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of climate change outweigh the positive ones.

Climate change will likely impact the Northern Spotted Owl in California, but the degree to which it is a threat to the species continued existence in the short- or long-term needs further investigation. During long-term landscape planning related to Northern Spotted Owls and their habitat, potential climate change impacts should be analyzed and incorporated.

Recreational Activity

Relatively few studies have been conducted on the impact of recreational activity on Northern Spotted Owls. A few studies suggest that stress levels increase in individual Northern Spotted Owls when exposed to motorcycle activities, timber harvest activities, and presence of hikers. It is clear recreational activities impact Northern Spotted Owls to some extent, but the level to which these activities may impact owls has yet to be determined. It is unlikely anthropogenic stress events associated with recreation will impact Northern Spotted Owl reproduction and survival to any great extent, though further research is warranted.

Loss of Genetic Variation

Loss of genetic variation is not considered to be a major threat to Northern Spotted Owls at this time. Some recent studies provide evidence that a population bottleneck may have occurred within the last few decades across the range of the Northern Spotted Owl; though no effect was documented for Northwest California.

Management Recommendations

The goal of the Department is to secure recovery and long-term survival of the Northern Spotted Owl across their historic range. The Department has evaluated existing management measures and has identified the following management recommendations, listed in no particular order, as necessary to help achieve the aforementioned goal. Many of these recommendations are adapted from the USFWS Northern Spotted Owl Recovery Plan (USFWS 2011a) and are based on the best available scientific

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5595 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where
5596 applicable. As new information becomes available, recommendations may be further refined.

5597 Planning and Timber Practices

- 5598 1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is
5599 consistent with the recovery of the species (see RA14).
- 5600 2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-
5601 range planning, setting priorities for scientific research and investigations, and/or when making
5602 major decisions affecting the Northern Spotted Owl (see RA5).
- 5603 3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative
5604 opportunities for nonfederal landowners to engage in management strategies (see RA15).
- 5605 4. Consider long-term maintenance of local forest management infrastructure as a priority in
5606 planning and land management decisions (see RA16).
- 5607 5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and
5608 contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of
5609 Northern Spotted Owls (see RA21).
- 5610 6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential
5611 recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in
5612 California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration,
5613 HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
- 5614 7. Improve thorough documentation of harvest prescription methods within timber harvest plans
5615 and a rigorous evaluation of post-harvest levels of foraging, nesting, and roosting habitat.
- 5616 8. Evaluate the effects of silvicultural practices on important prey species (e.g., flying squirrel,
5617 woodrat) and their habitat.

5618 Population Trend and Demographic Parameters

- 5619 9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if
5620 the California population is decreasing, stationary or increasing (see RA2).
- 5621 10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy
5622 across its California range (see RA3).
- 5623 11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival,
5624 population growth and reproductive rates of Northern Spotted Owls in California, and
5625 determine if negative impacts of climate change outweigh the positive ones.

5626 Habitat

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- 5627 12. Manage Northern Spotted Owl habitat in a way that accelerates the development of structural
5628 complexity and biological diversity that benefits Spotted Owl (see RA6)
- 5629 13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl
5630 habitat) while allowing for other threats, such as wildfire and insects, to be addressed by
5631 restoration management actions (see RA32).
- 5632 14. Conserve Northern Spotted Owl sites and high value habitat to provide additional demographic
5633 support to population dynamics (see RA10).
- 5634 15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to
5635 inform decisions concerning the possible development of habitat conservation networks in
5636 California (see RA4).
- 5637 16. Assess habitat requirements for, and barriers to, dispersal in California through research on
5638 Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and
5639 availability, and habitat modeling.
- 5640 17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath
5641 Province) to assist evaluating landscape-level issues in the Provinces in California, including
5642 monitoring and adaptive management actions (see RA7 and RA9).
- 5643 Wildfire
- 5644 18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).
- 5645 19. Retain large, dense patches of forests embedded in a matrix with reduced stand densities to
5646 limit the potential for stand-replacement fire and competitive pressure on old trees.
- 5647 20. Conduct experiments to better understand how vegetation management treatments (e.g.,
5648 thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern
5649 Spotted Owl habitat, prey abundance and distribution, and demographic performance (see
5650 RA11).
- 5651 a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in
5652 use of burned areas for foraging warrants additional research on long-term use of
5653 burned areas post-fire.
- 5654 21. Gather information on the effect of historical fire suppression and current fire regimes on owl
5655 habitat, especially on the quality of habitat as assessed through demographic rates at individual
5656 owl territories.
- 5657 22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of
5658 Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.

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5659 23. Develop a process for evaluating the likely effects of post-fire management activities, such as
5660 salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate
5661 this process into post-fire management decisions.

5662 24. Concentrate post-fire silvicultural activities on conserving and restoring habitat elements that
5663 take a long time to develop, such as large trees, medium and large snags, downed wood (see
5664 RA12).

5665 Barred Owl

5666 25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy,
5667 reproduction, and survival in California (see RA23).

5668 26. Promote experimental removal of Barred Owls within Northern Spotted Owl range, and if lethal
5669 removal is deemed a long-term management tool to manage negative effects of Barred Owls,
5670 explore methods for implementation within California (see RA22, RA29, and RA30).

5671 27. Investigate the potential for resource partitioning of Barred Owls and Northern Spotted Owls
5672 (see RA26).

5673 28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted
5674 Owl interactions.

5675 a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by
5676 the presence or absence of Barred Owls, but other unknown factors may also play a
5677 role.

5678 Disease and Contaminants

5679 29. Monitor prevalence and extent of sudden oak death within the Northern Spotted Owl range in
5680 California, and address as appropriate (see RA17).

5681 30. Investigate the potential influences of sudden oak death on Northern Spotted Owl habitat,
5682 occupancy, and prey species abundance over the short- and long-term.

5683 31. Expand assessment of the impacts of marijuana cultivation (both illegal and legal) on the
5684 Northern Spotted Owl and their habitat.

5685 a. The watersheds analyzed to date comprise only 4% of the Northern Spotted Owl range.
5686 Uncertainties in the dataset analyzed make it likely that the density of legal cultivation
5687 sites is higher than reported in the analysis. In addition, given the measured density of
5688 cultivation sites within Humboldt, Trinity and Mendocino counties potential impact of
5689 marijuana cultivation sites on spotted owl habitat should be evaluated further.

5690 b. Impacts of illegal cultivation to Northern Spotted Owls (e.g., habitat loss, exposure to
5691 toxins such and rodenticides) are largely unknown. Recent studies on anticoagulant

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5692 exposure in fisher suggests some unknown impact to the owl since prey-base is shared
5693 between the two species.

5694 32. Monitor prevalence of avian diseases (e.g., West Nile Virus, avian flu, *Plasmodium* spp.) in the
5695 Northern Spotted Owl population, and address as appropriate (see RA17).

5696 33. Investigate the extent of stress induced impacts on Northern Spotted Owl reproduction and
5697 survival due to recreational activities (e.g., hiking, off-road vehicular use).

5698 Listing Recommendation

5699 [TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]
5700

5701 Protection Afforded by Listing

5702
5703 The following is a discussion of potential protection that could be afforded to the Northern Spotted Owl
5704 in California if listed under CESA. While the protections identified in this section would help to ensure
5705 the future conservation of Northern Spotted Owls, there are protections now in place that would
5706 continue if the owl were not listed under CESA. These include current protections afforded under the
5707 Northern Spotted Owl federal status, protections afforded under the Forest Practice Rules, coverage of
5708 the owl under HCPs and NCCPs, current CEQA requirements, and existing laws and regulations that
5709 make it illegal under State law to take owls in California.

5710 It is the policy of the Department to conserve, protect, restore and enhance any endangered or any
5711 threatened species and its habitat (Fish & G. Code, § 2052.). The conservation, protection, and
5712 enhancement of listed species and their habitat is of statewide concern (Fish & G. Code, § 2051(c)).
5713 CESA defines “take” as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture,
5714 or kill. (Id. , § 86). Any person violating the take prohibition would be punishable under State law. When
5715 take is authorized through an incidental take permit, the impacts of the take must be minimized and
5716 fully mitigated, among other requirements.

5717 Increased protection of Northern Spotted Owl following listing would occur with required public agency
5718 environmental review under CEQA. CEQA requires affected public agencies to analyze and disclose
5719 project-related environmental effects, including potentially significant impacts on endangered, rare, and
5720 threatened species. Where significant impacts are identified under CEQA, the Department expects
5721 project-specific required avoidance, minimization, and mitigation measures will also benefit the species.

5722 CEQA would require analysis of potential impacts to Northern Spotted Owl regardless of listing status
5723 under CESA. In common practice, potential impacts to listed species is examined more closely in CEQA
5724 documents than potential impacts to unlisted species. State listing, in this respect, and required
5725 consultation with the Department during state and local agency environmental review under CEQA, is

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5726 also expected to benefit the species in terms of related impacts for individual projects that might
5727 otherwise occur absent listing.

5728 Without listing, Northern Spotted Owl take for research purposes is allowed via a Scientific Collecting
5729 Permit, and federal ESA 10a(1)(a). With listing, a state research Memoranda of Understanding (MOU)
5730 would also be required (Fish & G. Code, § 2081, subd. (a)). The added oversight allowed from MOU
5731 process is expected to benefit the species in terms of added coordination and research design, but will
5732 not likely add any additional protection.

5733 In listing the Northern Spotted Owl under CESA, the Department would expect an increased level of
5734 coordination among public agencies, such as USFS, CAL FIRE, and the USFWS, and with private timber
5735 companies, increased level of Department involvement in the THP review and approval process, more
5736 regular and thorough acquisition of data, and a reevaluation of current management practices for the
5737 species. In addition, if the Northern Spotted Owl is listed under CESA, the likelihood that land and
5738 resource management agencies will allocate funds towards protection and recovery actions may
5739 increase.

5740 **Economic Considerations**

5741
5742 The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).
5743

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6533 **Appendix 1. Forest Practice Rule definitions of silvicultural prescriptions.**

6534 The Forest Practice Rules differentiate silvicultural methods into four silvicultural categories. These
6535 silvicultural categories include even-aged management, uneven-aged management, intermediate
6536 treatments, and special prescriptions.

6537
6538 An Alternative silvicultural prescription can be included in a timber harvest plan when an alternative
6539 regeneration method or intermediate treatment is more effective or more feasible than any of the
6540 standard silvicultural methods.

6541 **Even-aged Management**

6542 Section 913.1 – Even-aged management are methods designed to replace a harvestable stand with well-
6543 spaced growing trees of commercial species.

6544 Clearcutting

6545 Section 913.1(b) – Clearcutting regeneration method involves the removal of a stand in one
6546 harvest.

6547 Seed Tree

6548 Section 913.1(c) – The seed tree regeneration method involves the removal of a stand in one
6549 harvest except for well distributed seed trees of desired species which are left singly or in
6550 groups to restock the harvested area.

6551 Seed Tree Seed Step

6552 Section 913.1(c)(1) – Seed Tree Seed Step: The seed tree seed step is the regeneration
6553 step and shall meet the following requirements:

6554 (A) Retention of at least the following basal area of seed trees per acre which are 18
6555 inches dbh or greater:

- 6556 1. Fifteen square feet basal area on site I, II and III lands and
- 6557 2. Twelve square feet basal area on site IV and V lands.

6558 The seed trees must be of full crown, capable of seed production and representative of
6559 the best phenotypes available in the preharvest stand.

6560 (B) No point within the logged area shall be more than 150 feet from a seed tree.

6561 (C) Seed tree species and site preparation measures shall be specified in the plan by
6562 the RPF.

6563 (D) Seed trees shall be marked by or under the supervision of an RPF prior to felling
6564 operations.

6565 (E) If natural regeneration is inadequate within two years after the first August
6566 following completion of timber operations, seed trees may be harvested and
6567 artificial regeneration shall be used to meet the requirements of Section
6568 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)].

6569 Seed Tree Removal Step

6570 Section 913.1(c)(2) – No more than 15 predominant trees per acre may be removed in
6571 the seed tree removal step. Not more than 50 sq. ft. of basal area of predominant trees
6572 per acre may be removed in the seed tree removal step. The seed tree removal step
6573 may be utilized when the regeneration present exceeds the minimum stocking
6574 requirements set forth in Section 912.7(b)(1)[932.7(b)(1), 952.7(b)(1)].

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Shelterwood

Section 913.1(d) – The shelterwood regeneration method reproduces a stand via a series of harvests (preparatory, seed, and removal). The preparatory step is utilized to improve the crown development, seed production capacity and wind firmness of designated seed trees. The seed step is utilized to promote natural reproduction from seed. The removal step is utilized when a fully stocked stand of reproduction has become established, and this step includes the removal of the protective overstory trees. The shelterwood regeneration method is normally utilized when some shade canopy is considered desirable for the establishment of regeneration.

Shelterwood Preparatory Step

Section 913.1(d)(1) – The shelterwood preparatory step shall meet the following minimum standards:

(A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.

1. Thirty square feet basal area on site I, II and III lands and

2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 100 ft. from a seed tree.

(C) Seed tree species shall be specified in the plan by the RPF.

(D) At least 125 sq. ft. of basal area per acre on Site I lands, and 75 sq. ft. of basal area per acre on Site II and III lands and 50 sq. ft. of basal area per acre on site IV and V lands shall be retained.

(E) The minimum stocking standards of 14 CCR § 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)] shall be met immediately upon completion of operations.

Shelterwood Seed Step

Section 913.1(d)(2) – The shelterwood seed step is the regeneration step and shall meet the following standards:

(A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.

1. Thirty square feet basal area on site I, II and III lands and

2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 100 ft. from a seed tree.

(C) Seed tree species and site preparation measures shall be specified in the plan by the RPF.

(D) Seed trees shall be marked by or under the supervision of an RPF prior to felling operations.

(E) If natural regeneration is inadequate within two years after the first August following completion of timber operations, seed trees may be harvested and artificial regeneration shall be used to meet the requirements of 14 CCR § 912.7(b)(1), [932.7(b)(1), 952.7(b)(1)].

(F) In the absence of a Sustained Yield Plan, to maintain and improve tree species diversity, genetic material and seed production, trees of each native commercial species where present at the time of harvest shall be retained after harvest.

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These leave trees shall be representative of the best phenotypes available in the preharvest stand. The RPF may propose and the Director may agree to a species specific plan in the THP which protects existing regeneration or provides for regeneration in-lieu of retaining trees.

Shelterwood Removal Step [Coast only]

Section 933.1(d)(3) - The shelterwood removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 912.7(b)(1). Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used once in the life of the stand. Regeneration shall not be harvested during the shelterwood removal step unless the trees are dead, dying or diseased or substantially damaged by timber operations. The minimum stocking standards of Section 912.7(b)(1) shall be met immediately upon completion of operations. The size limitations, and separation (spacing) by logical logging unit requirements, of Section 913.1(a) are applicable unless the post-harvest stand, regardless of average diameter, meets the stocking standards of Section 913.3(a)(1)(A) or (B)]. Not more than 32 predominant trees per acre may be removed in the shelterwood removal step. Not more than 100 square feet of basal area of predominant trees per acre may be removed in the shelterwood removal step.

Shelterwood Removal Step [Northern and Southern]

The shelterwood removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 932.7(b)(1) [952.7(b)(1)]. Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used once in the life of the stand. Regeneration shall not be harvested during the shelterwood removal step unless the trees are dead, dying or diseased or substantially damaged by timber operations. The minimum stocking standards of Section 932.7(b)(1) [952.7(b)(1)] shall be met immediately upon completion of operations. If the extent and intensity of the ground disturbance caused by the harvest is essentially the same as would have been caused by a clearcut or will cause adverse cumulative effects on wildlife as determined by the RPF or Director, the size limitations, and separation (spacing) by logical logging unit requirements of Section 933.1(a) [953.1(a)] are applicable unless the post-harvest stand, regardless of average diameter, meets area stocking standards of Section 933.3(a)(1)(A) or (B) [953.3(a)(1)(A) or (B)].

Uneven-aged Management

Sections 895.1 and 4593.2(c) – Uneven-aged management means the management of a specific forest, with the goal of establishing a well-stocked stand of various age classes and which permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop. Also defined in the SAF Dictionary of Forestry as “a stand of trees of three or more distinct age classes, either intimately mixed or in small groups”.

Selection/Group Selection

Section 913.2(a) – Under the selection regeneration method, the trees are removed individually or in small groups sized from 0.25 to 2.5 acres.

Transition

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Section 913.2(b) – The transition method may be used to develop an unevenaged stand from a stand that currently has an unbalanced irregular or evenaged structure. The transition method involves the removal of trees individually or in small groups from irregular or evenaged stands to create a balanced stand structure and to obtain natural reproduction.

Intermediate Treatments

Section 895.1 – Intermediate treatments means harvests conducted to modify or guide the development of an existing stand of trees, but not to replace (regenerate) the stand with a new one. The treatments involve the removal of trees to allow expansion of the crowns and root systems.

Commercial Thinning

Section 913.3(a) – Commercial thinning is the removal of trees in a young-growth stand maintain or increase average stand diameter of the residual crop trees, promote timber growth and/or improve forest health.

Sanitation-Salvage

Section 913.3(b) – Sanitation is the removal of insect attacked or diseased trees in order to maintain or improve the health of the stand. Salvage is the removal of only those trees which are dead, dying, or deteriorating, because of damage from fire, wind, insects, disease, flood or other injurious agent.

Special Prescriptions

Section 913.4 – Special Prescriptions are special harvesting methods which are appropriate under certain conditions.

Special Treatment Area

Sections 895.1 – Special Treatment Areas are specific locations which contain one or more of the following significant resource features which may be at risk during timber operations:

- a. Within 200 feet of the watercourse transition line of federal or state designated wild and scenic rivers;
- b. Within 200 feet of national, state, regional, county or municipal park boundaries;
- c. Key habitat areas of federal or state designated threatened, rare or endangered species;
- d. Coastal Commission special treatment areas;
- e. Within 200 feet of state designated scenic highways or within scenic corridors established pursuant to Article 2.5 (commencing with Section 260) of Chapter 2 of Division 1 and Section 154 of Chap. 1 of Div. 1 of the Streets and Highways Code.

Section 913.4(a) – Special consideration in Special Treatment Areas shall be given to selection of a regeneration method or intermediate treatment compatible with the objectives for which the special area was established. Such areas shall be identified in the plan. To assure the integrity of legally designated historical and archaeological sites and legally designated ecological reserves, and that the objectives of the special treatment areas are met, the RPF and the Director may agree, after on-the-ground inspection, if requested by either party, on specific silvicultural and logging practices to protect such areas. The Director shall notify affected agencies or groups with expertise in the resource involved in the special treatment area of any such areas located during the THP review process.

Rehabilitation

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6723 Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial
6724 timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7)
6725 prior to any timber operations on such lands, an area may be harvested provided it is restocked
6726 in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be
6727 included in the THP. The regeneration plan shall include site preparation, method of
6728 regeneration, and other information appropriate to evaluate the plan.
6729

6730 Fuelbreak/Defensible Space

6731 Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a
6732 shaded fuel break or defensible space in an area to reduce the potential for wildfires and the
6733 damage they might cause.
6734

6735 Variable Retention

6736 Section 913.4(d) - Variable retention is an approach to harvesting based on the retention of
6737 structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for
6738 integration into the post-harvest stand to achieve various ecological, social and geomorphic
6739 objectives.
6740

6741 Conversion

6742 Section 1100 – within non-timberland production zone (TPZ) timberland, transforming
6743 timberland to a nontimber growing use through timber operations.
6744

6745 **Alternative Prescription**

6746 A written analysis of preharvest and postharvest timber stand conditions and a description of the
6747 silvicultural practices and systems to be used in lieu of the standard methods. An Alternative silvicultural
6748 prescription can be included in a timber harvest plan when an alternative regeneration method or
6749 intermediate treatment is more effective or more feasible than any of the standard silvicultural
6750 methods.

6751 Section 913.6 – When an Alternative method is used, the plan must include a statement of which
6752 silvicultural method in the current District rules is most nearly appropriate or feasible and an
6753 explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how
6754 the proposed alternative prescription will differ from the most nearly feasible method in terms of
6755 securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in
6756 terms of fire, insect and disease protection.
6757

6758
6759 NonTimberland Area

6760 Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land,
6761 other than land owned by the federal government and land designated by the board as experimental
6762 forest land, which is available for, and capable of, growing a crop of trees of a commercial species used
6763 to produce lumber and other forest products, including Christmas trees.
6764

6765 Road Right of Way

6766 No strict definition
6767
6768

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6769 **Appendix 2: Forest Practice Rule definitions regarding Northern Spotted Owl or**
6770 **their habitat**

6771 **Activity Center (AC)** means a known northern Spotted Owl site documented from detections, pursuant
6772 to the USFWS document “Protocol For Surveying Proposed Management Activities That May Impact
6773 Northern Spotted Owls” revised March 17, 1992.

6774 (a) An AC is established by:

6775 (1) Resident Single Status is established by:

6776 (A) The presence or response of a single owl within the same general area on three or
6777 more occasions within a breeding season, with no response by an owl of the opposite
6778 sex after a complete survey;

6779 (B) Multiple responses over several years (i.e., two responses in year one and one
6780 response in year 2, from the same general area).

6781 (2) Pair Status Unknown is where the presence or response of two birds of the opposite sex is
6782 detected but pair status cannot be determined and where at least one member must meet the
6783 resident single requirements.

6784 (3) Pair Status wherein a male and female are heard and/or observed (either initially or through
6785 their movement) in proximity (less than one-quarter mile apart) to each other on the same visit;
6786 or a male takes a mouse to a female; or a female is detected on the nest; or one or both adults
6787 are observed with young.

6788 (4) Unoccupied Status where no responses have been obtained from a previously identified
6789 northern Spotted Owl activity center after 3 years of survey, barring other evidence to the
6790 contrary.

6791 An AC with unoccupied status will not be considered an AC when it has been evaluated and a
6792 determination made by the Director. The determination shall be based upon available information on
6793 survey history, habitat conditions within the home range, and changes to habitat that may have
6794 occurred since the northern Spotted Owl site was first identified.

6795 **Functional Foraging Habitat** is dependent upon the presence and availability of prey on the forest floor
6796 or in the canopy; presence of accessible perching limbs; and adjacency to stands with canopy closures
6797 >40%. Average stem diameter is usually >6" dbh for hardwoods and >11" dbh for conifers among
6798 dominants, and co-dominants, and the total overhead canopy closure, including intermediate trees is at
6799 least 40%. Where overall canopy closure is >80%, foraging habitat is limited to areas with ample flight
6800 space below limbs and among stems. Foraging habitat in smaller size classes and lower percentage
6801 canopy closures must be justified by local information.

6802 **Functional Nesting Habitat** means habitat with a dominant and co-dominant tree canopy closure of at
6803 least 40% and a total canopy (including dominant, co-dominant, and intermediates) of at least 60%.
6804 Usually the stand is distinctly multi-layered with an average stem diameter in dominant, and co-
6805 dominant conifers, and hardwoods >11" dbh. The stand usually consists of several tree species
6806 (including hardwoods) of mixed sizes. All nests, snags, down logs, and decadent trees shall also be
6807 considered as part of the habitat. Nesting substrates are provided by broken tops, cavities, or platforms

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6808 such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are
6809 known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with
6810 characteristics of topographic relief and aspect which alter microclimates.

6811 **Functional Roosting Habitat** during the territorial breeding season, consists of stands where
6812 average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers
6813 provide an average of at least 40% canopy closure but the stand can have a high degree of variability.
6814 Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for
6815 protection from various environmental conditions, including wind, heat, and precipitation.

6816 **Owl Habitat** means Type A, B, or C owl habitat or those areas with functional foraging habitat,
6817 functional nesting habitat, and functional roosting habitat which support the owl's biological needs for
6818 breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the
6819 functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls
6820 are known to occasionally inhabit less than optimal forest structure, local information can be used to
6821 justify the modification of functional habitat definitions.

6822 **Type A Owl Habitat** means timber stands that have as a minimum the following characteristics for
6823 live-tree structure:

- 6824 **1. Canopy layers:** The stand has two distinct tiers or is multi-layered with dominant
6825 conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for
6826 some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.
6827 **2. Canopy Closure:** The canopy closure of conifers greater than 120 ft. tall (or greater than
6828 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
6829 and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.
6830 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than nine
6831 stems per acre and not less than six stems per acre and includes a component of trees with sparse,
6832 broken, or dead tops.
6833 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6834 than 15 stems per acre and not less than 8 stems per acre.
6835 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
6836 than 50 stems per acre and not less than 20 stems per acre.
6837

6838 **Type B Owl Habitat** means timber stands that have as a minimum the following characteristics for
6839 live-tree structure:

- 6840 **1. Canopy Layers:** Moderately to strongly two-tiered or multi-layered with dominant
6841 conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some
6842 montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.
6843 **2. Canopy Closure:** The canopy closure of conifers greater than 100 ft. tall (or greater than
6844 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
6845 and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.
6846 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than six

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6847 stems per acre and not less than two stems per acre.

6848 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6849 than 25 stems per acre and not less than 20 stems per acre.

6850 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
6851 than 50 stems per acre and not less than 20 stems per acre.

6852 **Type C Owl Habitat** means timber stands that have as a minimum the following characteristics for
6853 live-tree structure:

6854 **1. Canopy Layers:** Uniform to moderately layered with dominant conifers or hardwoods 50
6855 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.

6856 **2. Canopy Closure:** The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages
6857 greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is
6858 greater than 60%.

6859 **3. Large Trees:** The density of conifers greater than 35 inches dbh averages less than six
6860 stems per acre and may be absent.

6861 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6862 than 15 stems per acre, but may be absent.

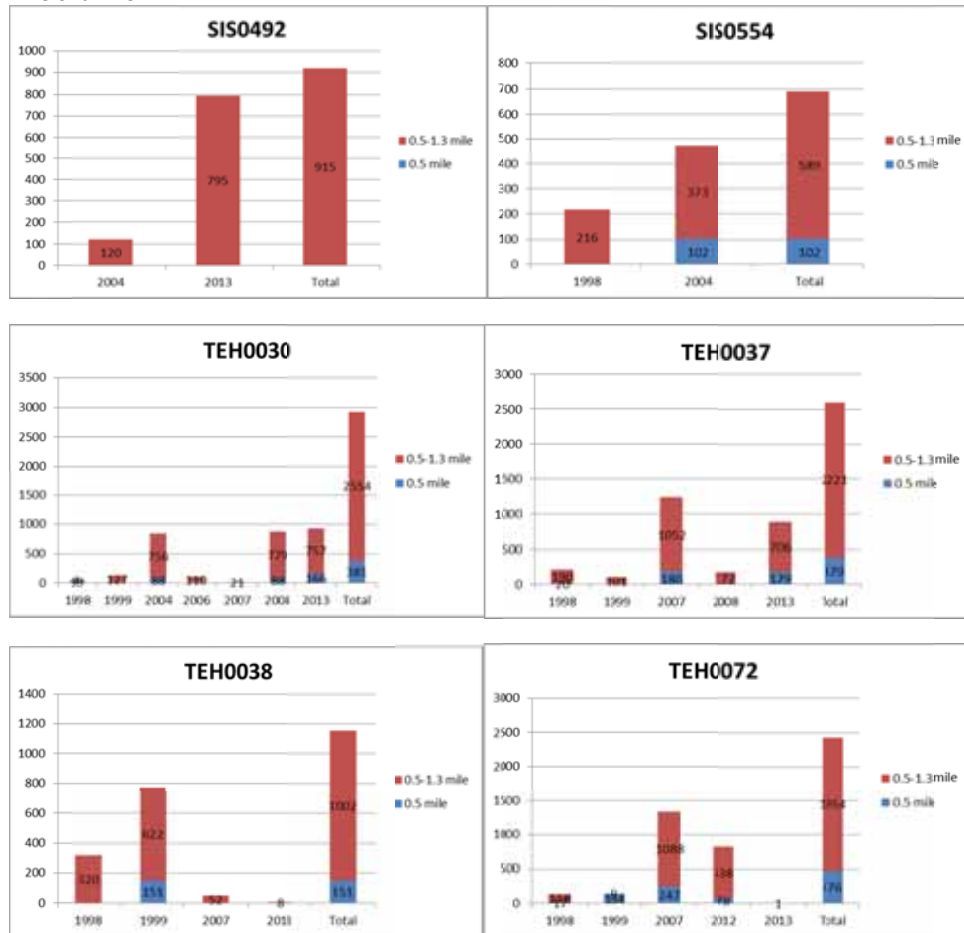
6863 **5. Small Trees:** The density of conifers or hardwoods less than 18 inches dbh averages
6864 more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the
6865 stand, including small, medium, and large trees is greater than 10 inches.

6866

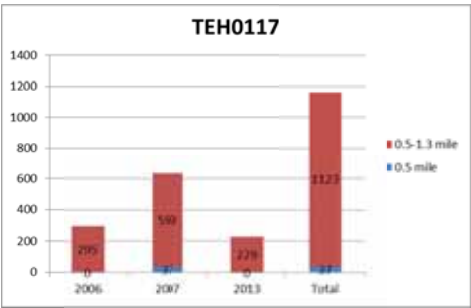
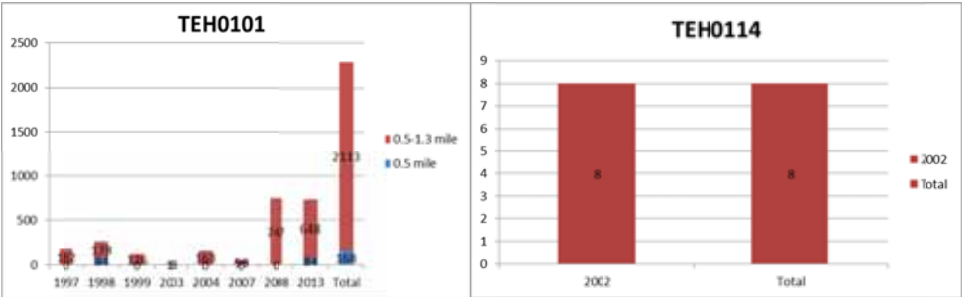
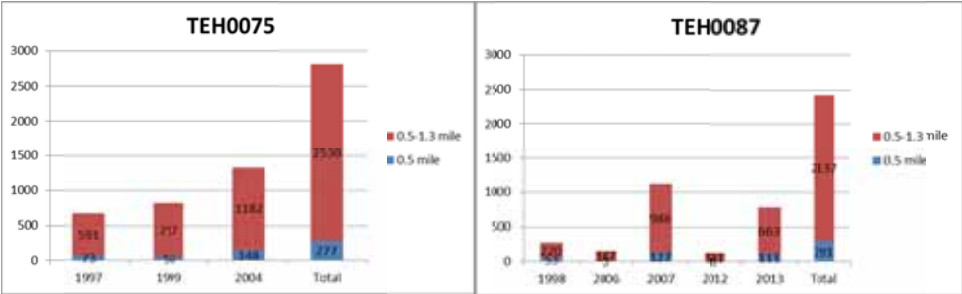
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Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

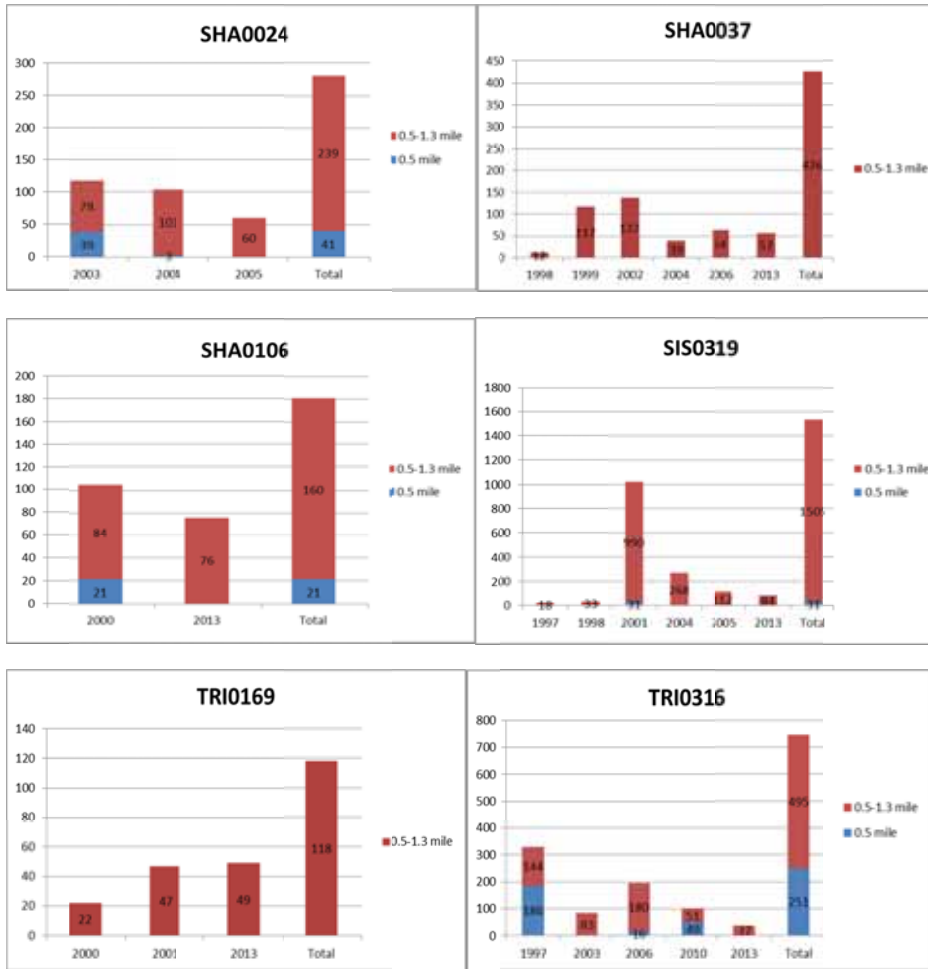


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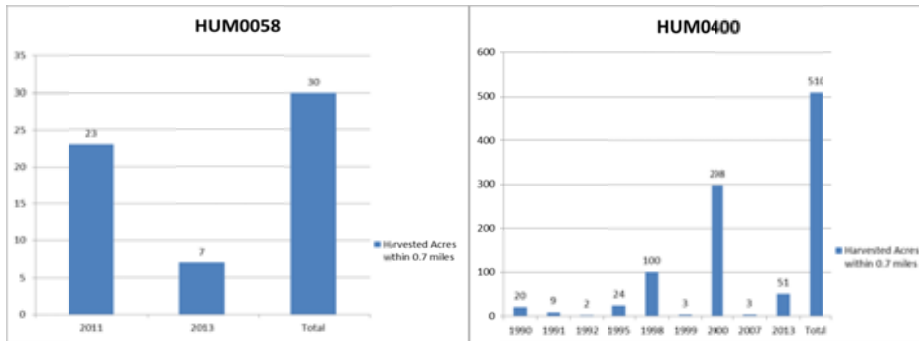
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6882 THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3
6883 mile of an AC

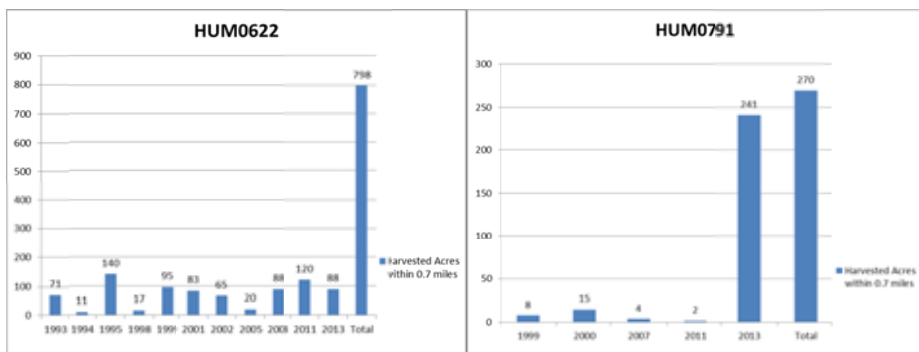


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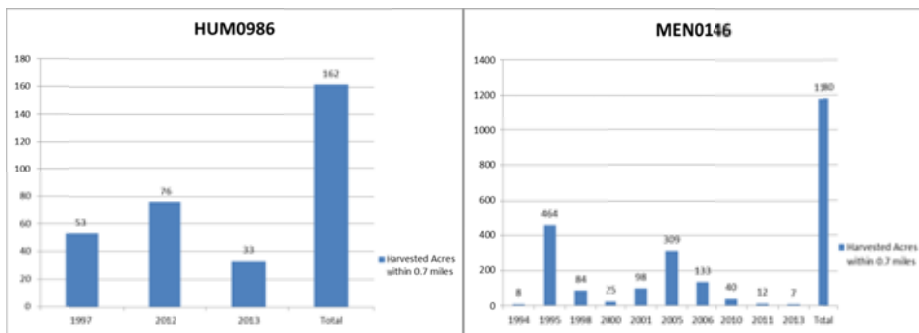
6883 THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



6889

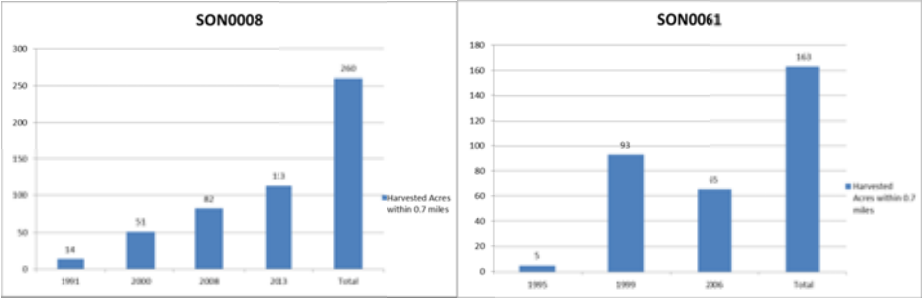
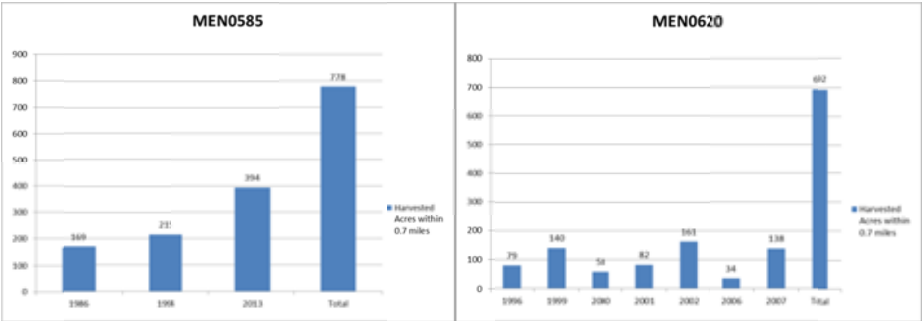
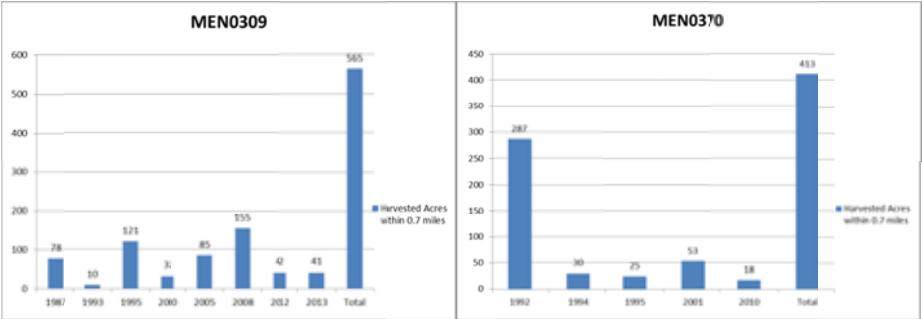


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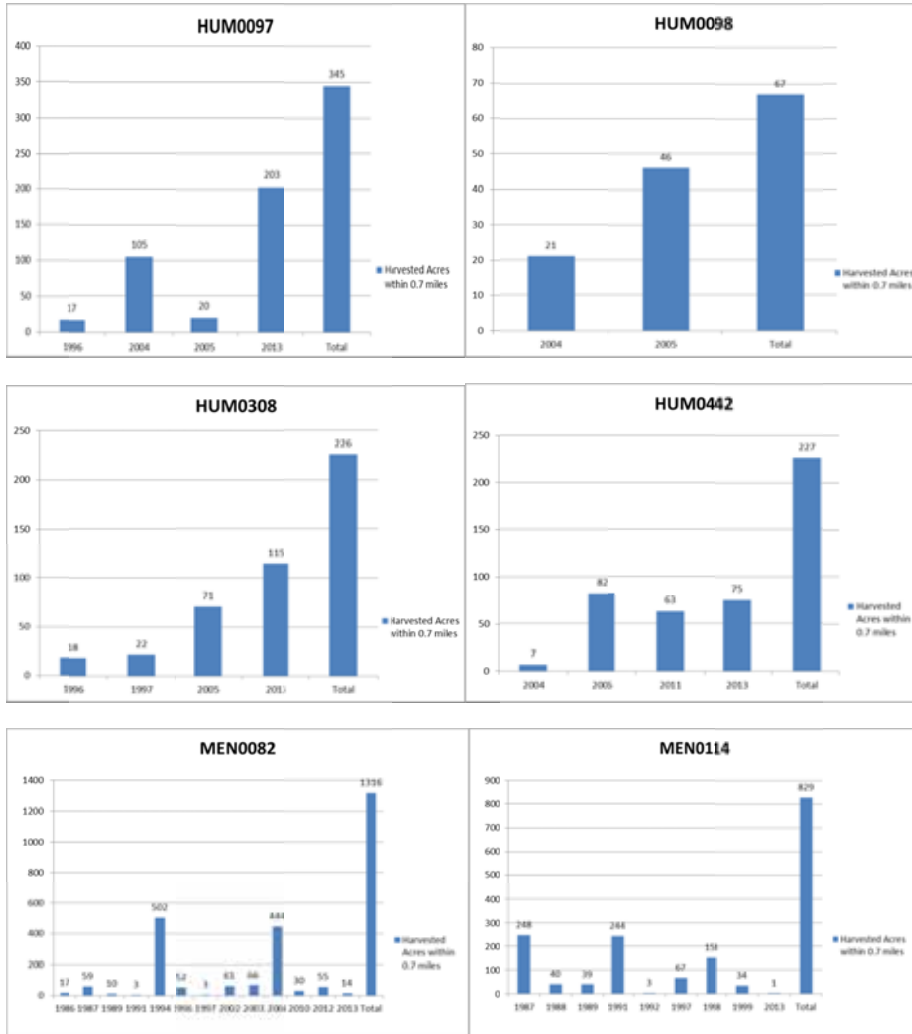
6890

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6897 THP’s utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



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6902	Appendix 4. List of Acronyms and Abbreviations
6903	
6904	AC Activity Center
6905	AMA Adaptive Management Areas
6906	AR Anticoagulant Rodenticides
6907	BLM Bureau of Land Management
6908	Board Board of Forestry and Fire Protection
6909	BO Biological Opinion
6910	BOE Board of Equalization
6911	BOF State Board of Forestry and Fire Protection
6912	CA State Parks California Department of Parks and Recreation
6913	CAL FIRE California Department of Forestry and Fire Protection
6914	Caltrans California Department of Transportation
6915	CBD Center for Biological Diversity
6916	CD Consistency Determination
6917	CEQA California Environmental Quality Act
6918	CESA California Endangered Species Act
6919	CCAA Candidate Conservation Agreement with Assurances
6920	CDFW California Department of Fish and Wildlife
6921	CI Confidence Interval
6922	CNDDB California Natural Diversity Database
6923	Commission Fish and Game Commission
6924	CPV Canine Parvovirus
6925	CSA Conservation Support Areas
6926	CWHR California Wildlife Habitat Relationships
6927	DBH Diameter at Breast Height
6928	DSA Density Study Area
6929	Department California Department of Fish and Wildlife
6930	EIR Environmental Impact Report
6931	EPA Environmental Protection Agency
6932	ESA Federal Endangered Species Act
6933	FEIS Final Environmental Impact Statement
6934	FRGP Fisheries Restoration Grant Program
6935	FGS Fruit Growers Supply Company
6936	FEMAT Forest Ecosystem Management Assessment Team
6937	FIA Forest Inventory Analysis
6938	FMP Forest Management Plan
6939	FPA Forest Practice Act
6940	FRI Fire Return Interval
6941	FSC Forest Stewardship Council
6942	GDR Green Diamond Resource Company study area
6943	GDRC Green Diamond Resource Company
6944	ITP Incidental Take Permit
6945	ITS Incidental Take Statement
6946	JDSF Jackson Demonstration State Forest
6947	HCP Habitat Conservation Plan
6948	HFP Habitat Fitness Potential

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6949	HCVF	High Conservation Value Forests
6950	HUP	Hoopa Indian Reservation study area
6951	HRC	Humboldt Redwood Company
6952	LSA	Late-Successional Areas
6953	LSAA	Lake or Streambed Alteration Agreement
6954	LSR	Late-Successional Reserve
6955	MBF	1,000 board-foot
6956	MIS	Management Indicator Species
6957	MMCA	Marbled Murrelet Conservation Areas
6958	MRC	Mendocino Redwood Company
6959	NCA	National Conservation Area
6960	NCCP	Natural Community Conservation Plan
6961	NIPF	Non-industrial private forest
6962	NPS	National Park Service
6963	NSO	Northern Spotted Owl
6964	NTMP	Nonindustrial Timber Management Plans
6965	NTO	Notice of Operations
6966	NWC	Northwest California study area
6967	NWFP	Northwest Forest Plan
6968	ORV	Off Road Vehicle
6969	PCB	Private Consulting Biologists
6970	PFT	Pacific Forest Trust
6971	PL	Pacific Lumber Company
6972	PRNS	Point Reyes National Seashore
6973	PSU	Primary Sampling Unit
6974	REF	Suppressed reproduction and growth
6975	RNSP	Redwood National and State Parks
6976	ROD	Record of Decision
6977	RPF	Registered Professional Foresters
6978	SEIS	Supplemental Environmental Impact Statement
6979	SHA	Safe Harbor Agreement
6980	SOMP	Spotted Owl Management Plans
6981	SOP	Spotted Owl Expert
6982	SORP	Spotted Owl Resource Plan
6983	SFI	Sustainable Forestry Initiative
6984	SP	State Park
6985	SPI	Sierra Pacific Industries
6986	TCP	Timberland Conservation Planning Program
6987	THP	Timber Harvest Plan
6988	TPZ	Timber Production Zone
6989	UCNRS	UC Natural Reserve System
6990	USFWS	U.S. Fish and Wildlife Service
6991	USFS	U.S. Forest Service
6992	USDA	United States Department of Agriculture
6993	USDI	United States Department of Interior
6994	USFS	United States Forest Service
6995	WCSA	Willow Creek Study Area
6996	WLPZ	Watercourse and Lake Protection Zones

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6997 WNV West Nile virus
6998

Comments from Rocky Gutierrez, Ph.D.

From: [R. J. Gutiérrez](#)
To: Battistone_Carie@Wildlife
Cc: Clipperton_Neil@Wildlife
Subject: Re: Northern Spotted Owl Status Review - External Peer Review
Date: Monday, October 19, 2015 2:45:16 PM
Attachments: [image001.jpg](#)
[review of NSO listing under CESA Oct 2015 Gutierrez.docx](#)
[Gutierrez CV October 2015.doc](#)

Dear Neil and Carrie:

Attached is my summary review of the department's listing document. Given the nature of the review, I did not use my official affiliation. Rather I am attaching a CV if you need it to justify why you selected me. Of course you can use my affiliation I just don't want the University of Minnesota to be held responsible for "endorsing" my review. This might seem paranoid but it has happened before with spotted owl information is commented on.

Sincerely,

Rocky

R. J. Gutiérrez, Professor and
Gordon Gullion Endowed Chair
Department of Fisheries, Wildlife, and Conservation Biology
University of Minnesota
St. Paul, MN 55108

Phone: 612-916-1987

Fax: 612-625-5299

website: <http://fwcb.cfans.umn.edu/research/owls/>

"The most dangerous worldview is the worldview of those who have not viewed the world" - Alexander von Humboldt

On Thu, Oct 15, 2015 at 2:30 PM, Battistone, Carie@Wildlife
<Carie.Battistone@wildlife.ca.gov> wrote:

Good morning Rocky,

I was hoping you could give us a date you expect to have your comments back to us. Do you know when this might be? We don't want to push your review, but we do need to plan our schedule for getting a final draft submitted to the Fish and Game Commission.

Thank you,

Carie Battistone

Statewide Raptor Coordinator

Wildlife Branch

California Department of Fish and Wildlife

[\(916\) 445-3615](tel:(916)445-3615)

Carie.Battistone@wildlife.ca.gov

www.wildlife.ca.gov

From: R. J. Gutiérrez [mailto:gutie012@umn.edu]

Sent: Wednesday, September 23, 2015 3:45 PM

To: Battistone, Carie@Wildlife

Subject: Re: Northern Spotted Owl Status Review - External Peer Review

Hi Carie:

Are the figures to which you refer the ones in Appendix 3 in the document I downloaded? If they are I won't bother trying to create an entry.

As far as your questions. 1. I was able to download the document - a huge document. 2. It will be very tight to make the deadline given the short time frame for review and the fact that I have been home about 5 days since late July (research trips to Japan, Iceland, and Minnesota). I returned to CA on Monday night and I leave Friday for the field and won't return until the 5th of October. I will try to print the document out as I will have no electricity in the field so can't use the computer as a reading platform. I also cannot work on it this week as I am editing a California spotted owl assessment document for the USFS and part of that is due Friday. Sorry but I did not predict the document to arrive at such a bad time for my schedule. If I do respond it will be primarily an overview of my impressions, I will not have time to make detailed comments obviously.

Sorry about this, but it is what it is. Normally for a document of this length I will be given several months to review it.

Rocky

R. J. Gutiérrez, Professor and

18 October 2015

Mr. Neil Clipperton
California Department of Fish and Wildlife
Nongame Bird Conservation Coordinator
Wildlife Branch
1812 9th Street
Sacramento, CA 95811

Dear Mr. Clipperton:

Thank you for the opportunity to review the California Department of Fish and Wildlife's "Status Review of the Northern Spotted Owl in California" for potential listing of the northern spotted owl under the California Endangered Species Act (CESA). I apologize for my tardiness in returning this review, but I have been traveling internationally quite extensively since I received the document. Therefore, I here provide only my general impressions without detailed comments on the text itself.

I was impressed by the thoroughness of the status review. Clearly much effort and thought were devoted to the effort and while I can quibble with the presentation, I think the presentation can easily be fixed by thorough editing. Although a listing recommendation was deferred (page 164) until the review process was completed, my interpretation of the results is that the northern spotted owl clearly should be listed as endangered under the CESA. I would concur with such a conclusion.

While I think most of your interpretations of literature are accurate, the genetic/phyllogeography interpretations and assessments of the literature are somewhat problematic. For example, although you list Barrowclough et al. (2011) as a citation, I did not see where you cited it in a relevant section (taxonomy and genetics) where it should have been relative to the hybrid zone between California and northern spotted owls in California. The interpretation of Funk et al. (2008) regarding dispersal of Mexican spotted owls into the northwest is probably incorrect owing to the length of

time coalescence between nuclear vs. mtDNA markers. This leads to the obvious lack of citation of Barrowclough et al. (1999) who showed a novel and unexpected pattern of relationships among the three subspecies. Finally, you twice referred to the evidence of bottlenecks in northern spotted owls (Funk et al. 2010) as “compelling” but this paper is far from compelling owing to the limitations of these genetic bottleneck tests (see Perry et al. 2012a for a general discussion of these limitations). Thus, while I think it relevant to cite this work I would not emphasize it as there are serious scientific limitations with drawing inference from that type of information using their methods. Moreover, it is not particularly relevant to your assessment of current status.

One area that I thought that you have incorrectly characterized (in terms of its breadth and depth) is the demographic work of spotted owls. In a summary section (starting with line 5397) you seemed to imply there is a lack of information about the demography of spotted owls in California. However, you cannot decouple what has been done in California with what has been done elsewhere in the range of the owl owing to the integrated analyses of these extensive data sets (i.e., meta-analysis). This is because there are range-wide trends with which the California populations are correlated (see Green Diamond company study results for an important exception on part of their land, see below). Moreover, these demographic studies, which include three California study areas, represent the single best population (demographic) information on an endangered species ever assembled in the world (Gutiérrez 2008). This statement is likely also true of the habitat work on spotted owls (Löhms 2004). I noted in a comment box that you may update the demographic information as appropriate, but this reemphasizes is warranted. I also recommend you use data from the most recent meta-analysis as you implied you might. I served as the associate editor for Condor handling the most recent review of the meta-analysis of trends in owl populations, and although the paper is in press, the results should be available from Katy Dugger for citation as “in press.” Although I am not at liberty to discuss this information owing to my position as the associate editor, Dr. Dugger can send you the accepted or revised draft article if you request it from her. The most recent information indeed provides “compelling” evidence for decline of both California and other state populations of the northern spotted owl as well as barred owl effects on spotted owls occupying Green Diamond land.

I found Table 8 interesting (and suspect) because essentially all private land except Green Diamond and Campbell Global apparently have reported occupancy trends that were stable. It is suspect especially because Diamond’s estimates are peer rigorous, peer-reviewed, and published (in press) and they show a decline where barred owls have not been controlled. I have seen no peer-reviewed papers presenting occupancy information for these various land ownerships. Thus, I question the quality of these

private land occupancy data and whether much credence can be given to them until they are peer-reviewed and published. I also found the discussion of various land agencies/areas important. However, I think it might be worth mentioning the abject failure of the National Park Service to respond to the invasion of barred owls. A conclusion of failure seems reasonable given your description of their “restoration” efforts using logging as a management tool, yet they have done nothing to control barred owls. Barred owl management action also seems particularly warranted and important at Point Reyes National Seashore where control efforts would be minimal owing to low barred owl population size in Marin Co., the ease of barred owl removal, and the relative isolation of the area which limits barred owl dispersal coupled with a relatively high current density of spotted owls. I mention this as a failure because in the lexicon of the ESA, this could be considered a “failure of existing regulatory mechanisms.”

Regarding the second issue on timber harvest (starting on page 107), I suggest providing a table or description of the options being discussed. The average reader will not be willing to read the various statutes quoted and, therefore, will have no idea what are the options “e, g, and the alternative” entail. Perhaps the information is somewhere in the document, but I did not see it. Also under this section, I did not understand what you were trying to convey in lines 3621-3625. Finally, I found the timber harvest and hardwood harvest section somewhat muddled and confusing. Thus, I suggest that you revise this section without using jargon and using simple declarative language because timber harvest is a key issue for evaluating the status and management of the owl (see comments below regarding the interaction of barred owls and timber harvest effects).

Under regulatory mechanisms, one assessment that did not seem to be made was the consequence of “decommissioning” owl locations following multiple years of no detection. The consequence of removing these areas from protection is that it results in a net loss over time of habitat that could potentially be reoccupied at some future time. You discuss the consequence of forest practice rules on habitat loss, but I think this could be expanded to include this issue, which I did not see examined explicitly.

Marijuana cultivation was discussed under habitat loss and the potential for poisoning from rodenticides discussed elsewhere. There is emerging evidence (see Higley’s unpublished work at Hoopa and Diller’s work on Green Diamond land with barred owls) that poisoning is a much more serious threat than portrayed in your report. Moreover, you make the case that legalization of “medical” marijuana has led to the increase in growing, but my sense in living on the north coast of California is that state and federal law enforcement, including the California Fish and Wildlife, have essentially capitulated to the pot growers (I recognize that some enforcement occurs, but it pales in comparison to the activity that is easily detectable), which has

encouraged growing just as much as legalization has. The legal growers are known, but the vast majority of growers are not legally licensed. I draw this conclusion because it is easy to use google earth to detect “grows” and see the extent to which marijuana cultivation is occurring in rural and wild landscapes in northwestern California. Thus, it seems logical that the lack of enforcement explains part of why these “grows” are still rampant on the landscape. I realize that you did watershed analysis to assess the extent of growing in some areas, but the non-target impacts of poison used by these pot growers have to be substantial on wildlife, including spotted owls given the detection of residues in barred owls on Hoopa and Green Diamond lands (or in the latter case most likely stemming from owls on Green Diamond foraging on adjacent small private land parcels). So I suggest the potential negative effects of marijuana cultivation because of poisons need to be elevated in the status review.

I thought the section on fire was comprehensive and provided a good perspective on the issue. One common theme about fire effects on spotted owls that I have encountered is that fires are responsible for recent declines of owls. Recent fires (like the Biscuit fire you discussed) have not been the driver for declines of spotted owls over recent time (past 3 decades). They contribute to it but are not the sole reason or even the major reason for it. Fire has been used as a reason for the decline and as a justification for logging and salvage. I am not arguing against either logging or salvage because I think they can be conducted in a sustainable and ecological beneficial manner, but I think it important to highlight that fire has not been the reason for the estimated declines in northern California and range-wide. In the future, particularly when considering potential effects of climate change, fire (rather the potential increase in high severity fires) could be a problem. These distinctions need to be clearly made otherwise management objectives, regulations, and methods can be easily obfuscated.

On climate change, lines 4391-4392 should be revised. While it is true that adaption (in the evolutionary sense, which is how I interpreted the use of “adapt” here) is a mechanism by which species might cope with climate change - so also are range and spatial shifting. Predictions from climate change scenarios for spotted owls in the southwest for example (Peery et al. 2012b) suggest that owls may have the potential to track habitat as vegetation communities shift in response to climate change. The capacity to evolve (i.e., adapt) actually is a very different owing to its bases in natural selection and perhaps more difficult prospect for spotted owls than simply range shifting or tracking of habitat.

The section on barred owls nicely captures some of the nuances of this recent biological invasion. The discussion of the actual mechanism for the invasion is less important than the general result that changes in the landscape that likely led to the invasion were probably caused by the activities of humans. This by itself warrants serious

consideration of efforts by humans to manage the invasion. Management of invasive species is commonly done to protect many endangered bird species. Birds are sometimes controlled even when they are only “suspected” to be the causative agent in the decline of species we wish to enhance (e.g., sport fish and cormorants in Minnesota), so a discussion of this topic seems relevant as a management response to barred owls. The most recent meta-analysis (in press) again appears to provide “compelling” (because is derived from a quasi-experiment) evidence about barred owl effects on spotted owls. Moreover, management actions are inexpensive and technically simple (see Diller et al. 2014 – this reference is not cited in the document).

Salvage logging is controversial given the desire to leave snags as ecological legacies and the uncertainty of fire effected tree mortality relative to mixed severity fires. That is, high severity fires that result in stand replacing events are certainly candidates for salvage logging, but snag retention guidelines have not been well justified in recent documents although they were in the first draft recovery plan in 1992. In that plan, the recommendation was to retain most of the large trees killed by fires and to salvage the smaller trees (< 30 inches dbh). In mixed severity fires, there is the uncertainty about tree mortality in some instances such that if a liberal salvage approach is taken to harvest trees, the site could be rendered useless to owls for the foreseeable future. Thus, the manner in which salvage is conducted or permitted could be constructive or destructive to owl habitat.

In summary, I commend the status review team on their excellent, comprehensive summary of information about northern spotted in California. The document captured the essence of most of the issues related to the decline of spotted owls in northern California. While I think some areas can be enhanced, as noted regarding interactions among factors likely responsible for decline, the status review portrays the serious decline of the owl and the factors likely responsible. The status review clearly points to a listing of the northern spotted owl under CESA.

Sincerely,

R. J. Gutiérrez, PhD

CV attached for credentials

Literature cited:

- Barrowclough, G. F., R. J. Gutiérrez, and J. G. Groth. 1999. Phylogeography of spotted owl (*Strix occidentalis*) populations based on mitochondrial DNA sequences: gene flow, genetic structure, and a novel biogeographic pattern. *Evolution* 53:919-931.
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- Gutiérrez, R. J. 2008. Spotted Owl Research: a quarter century of contributions to education, ornithology, ecology, and wildlife management. *Condor* 110:792-798.
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- Perry et al. 2012a. Reliability of genetic bottleneck tests for detecting recent population declines. *Molecular Ecology* 21: 3403–3418.
- Peery, M. Z., Gutiérrez, R. J., Kirby, R., LeDee, O. E., LaHaye, W. S. 2012b. Climate change and spotted owls: potentially contrasting responses in the southwestern United States. *Global Change Biology* 18:865-880.

Comments from John Hunter

From: [Hunter, John](#)
To: [Clipperton, Neil@Wildlife](mailto:Clipperton.Neil@Wildlife)
Cc: [James Bond](#)
Subject: review of NSO status review
Date: Friday, September 18, 2015 10:37:59 AM
Attachments: [NSO SR external peer review Final 8Sept2015 JEHcomments.docx](#)

Neil,

Here is my review of the document. Let me know if you need any of the new citations I included (e.g., Schmidt 2015) if you need them.

Thanks for the opportunity to comment on this status review.

--

John E. Hunter
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707-822-8411 (fax)
John_E_Hunter@fws.gov

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
NORTHERN SPOTTED OWL
(*Strix occidentalis caurina*) IN CALIFORNIA



CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
EXTERNAL REVIEW DRAFT, September 8, 2015



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Comment [A1]: Note to external reviewers:
These appendices will be added later.

Acknowledgments (to be completed after external review)

This report was prepared by: Neil Clipperton and Carie Battistone

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**Report to the Fish and Game Commission
A Status Review of the Northern Spotted Owl in California
EXTERNAL REVIEW DRAFT, September 8, 2015**

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Executive Summary

[TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]

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Regulatory Framework

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Petition Evaluation Process

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A petition to list the Northern Spotted Owl as threatened or endangered under the California Endangered Species Act (CESA) was submitted to the Fish and Game Commission (Commission) on September 7, 2012 by the Environmental Protection Information Center. A petition evaluation report was prepared by the Department of Fish and Wildlife (Department) and submitted on February 14, 2013, to assist the Commission in making a determination as to whether the petitioned action may be warranted based on the sufficiency of scientific information (Fish & G. Code, §§ 2073.5 & 2074.2; Cal. Code Regs., tit. 14, § 670.1, subds. (d) & (e)).

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The Department's charge and focus in its advisory capacity to the Commission is scientific. A petition to list or delist a species under CESA must include "information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The Petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and other factors the Petitioner deems relevant" (Fish & G. Code, § 2072.3). Given this charge the Department recommended to the Commission that the petition be accepted.

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258 **Status Review Overview**

259 The Commission published findings of its decision to advance the species to candidacy on December 27, 2013, triggering a 12-month period
260 during which the Department conducted a status review to inform the Commission’s decision on whether to list the species. Per Fish & G. Code,
261 section 2074.6, the Department requested a 6-month extension, to allow further analysis and evaluation of the available science, completion of
262 the status review, and peer review process. Due to the extension, Department had a total of 18 months from December 27, 2013 to deliver the
263 status review to the Commission.

264 This written status review report indicates, based upon the best scientific information available, whether the petitioned action is warranted,
265 preliminary identifies habitat that may be essential to the continued existence of the species, and recommends management activities and other
266 recommendations for recovery of the species (Fish & G. Code, § 2074.6). Receipt of this report is to be placed on the agenda for the next
267 available meeting of the Commission after delivery. At that time, the report will be made available to the public for a 30-day public comment
268 period prior to the Commission taking any action on the Department’s recommendation.

269 **Existing Regulatory Status**

270 *Endangered Species Act*

271 The U.S. Fish and Wildlife Service listed the Northern Spotted Owl as threatened under the Endangered Species Act in 1990. Critical habitat
272 designation occurred in 1992 and was revised in 2008, and a new final rule designating critical habitat was published in December 2012. The first
273 final recovery plan for the Spotted Owl was issued in 2008 and revised in 2011.

274 *Migratory Bird Treaty Act*

275 The Migratory Bird Treaty Act prohibits anyone from taking, killing, or keeping any native bird, its parts, or its nest, without a permit or license.
276 All raptors native to the U.S. are covered by this law. A Special Purpose Possession Permit and/or Endangered Species Permit (depending on
277 species), is required under the Migratory Bird Treaty Act to keep raptors.

278 *California Endangered Species Act*

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279 After the Commission voted to accept the petition in December, 2013, the Northern Spotted Owl became a State candidate for threatened or
280 endangered status under the California Endangered Species Act, commencing with section 2050 of the California Fish and Game Code

281 *California Bird Species of Special Concern*

282 The Department currently designates the Northern Spotted Owl as a Species of Special Concern.

283 *Fish and Game Code*

284 The Fish and Game Code includes certain protections for raptors, including the Northern Spotted Owl. Sections applicable to owls include the
285 following:

286 Section 3503 - It is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this
287 code or any regulation made pursuant thereto.

288 Section 3503.5 - It is unlawful to take, possess, or destroy any birds in the orders Falconiformes or Strigiformes (birds-of-prey) or to take,
289 possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant
290 thereto.

291 Section 3513 - It is unlawful to take or possess any migratory nongame bird as designated in the Migratory Bird Treaty Act or any part of
292 such migratory nongame bird except as provided by rules and regulations adopted by the Secretary of the Interior under provisions of
293 the Migratory Treaty Act.

294 *California Board of Forestry and Fire Protection*

295 The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire Protection (CAL FIRE) have designated
296 Northern Spotted Owl as a “Sensitive Species” as identified in the California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter
297 Forest Practice Rules). These sections also define Northern Spotted Owl -related terminology, including “activity center”, “Northern Spotted Owl
298 breeding season”, and “Northern Spotted Owl Evaluation Area.” Specific requirements for the disclosure of information on Northern Spotted
299 Owls in the context of timber harvesting, which in all but one case avoid take of Northern Spotted Owl are provided by Forest Practice Rules
300 sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted Owl required in project documents submitted

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301 to CAL FIRE. This information is intended to be utilized by CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with
302 timber harvest and related activities, would be avoided according to the criteria for determining take avoidance found in Section 919.10. Other
303 language within Section 919 also compels methods to avoid take of Northern Spotted Owl. Sections 919.2 and 919.3 set up protections of bird
304 nests through buffers and avoidance of sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the
305 protections afforded to late successional forests, which are a component of Northern Spotted Owl habitat.

306 *International Union for Conservation of Nature*

307 The International Union for Conservation of Nature Red List of Threatened Species status for the Spotted Owl range-wide is “Near Threatened”
308 because the “species has a moderately small population which continues to decline in northern and western parts of its range.”

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Biology and Ecology of the Northern Spotted Owl

Life History

Species Description

The Northern Spotted Owl is a medium-sized dark brown owl, with a barred tail, white spots on its head and breast, and dark brown eyes surrounded by prominent facial disks (Forsman et al. 1993, Gutiérrez et al. 1995). Overall, its length is approximately 46 to 48 centimeters (18 to 19 inches) (Forsman et al. 1993). Males and females are dimorphic in size, with males averaging about 13 percent smaller than females (USFWS 2011a). Males weigh between 430 to 690 grams (0.95 pound to 1.52 pounds), and females weigh between 490 to 885 grams (1.1 pounds to 1.95 pounds) (P. Loschl and E. Forsman pers. comm. 2006 in USFWS 2011a). The Northern Spotted Owl resembles the Barred Owl in appearance, and first generation hybrids of the two species exhibit physical and vocal characteristics of both (Hamer et al. 1994, Kelly and Forsman 2004).

Taxonomy and Genetics

The American Ornithologists' Union recognizes the Northern Spotted Owl as one of three subspecies of Spotted Owls. The two other subspecies are the California Spotted Owl (*S. o. occidentalis*), ranging in the southern Cascade Range of northern California south along the west slope of the Sierra Nevada and in mountains of central and southern California, and Mexican Spotted Owl (*S. o. lucida*) ranging from southern Utah and Colorado south to Michoacán, Mexico. The taxonomic separation of these three subspecies is supported by genetic, morphological, and biogeographic information (Barrowclough and Gutiérrez 1990, Gutiérrez et al. 1995, Haig et al. 2004a, Chi et al. 2005, Henke et al. 2005, Barrowclough et al. 2005, Funk et al. 2008, AOU 2011, Barrowclough et al. 2011). The Marin County population of Northern Spotted Owl is genetically isolated from other Spotted Owl populations in California (Jenson et al. 2006).

There is a narrow, apparently stable zone where hybridization occurs between the Northern and California Spotted Owl in the Southern Cascades and Northern Sierra Nevada Mountains near the Pit River in California (Courtney et al. 2004, Barrowclough et al. 2005). There is evidence in all genetic studies conducted on the species of some genetic mixing of California Spotted Owl into the Northern Spotted Owl range, and fewer examples of the opposite (Courtney et al. 2004). In the Klamath region of California 20.3% of owls were classified as California Spotted Owls (Haig et al. 2004a). Among all Northern Spotted Owls sampled across their range in Oregon, Washington, and California, 12.9% contained California Spotted Owl haplotypes (Haig et al. 2004a). There has been some evidence for genetic flow between Mexican Spotted Owls and Northern Spotted Owls, primarily in Washington, indicating long-distance dispersal of Mexican Spotted Owls most likely via the Rocky Mountain

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dispersal route (Funk et al. 2008). Until recently, there has been little evidence in the literature of loss of genetic variation and population bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across the range of the Northern Spotted Owl (Washington Cascade Mountains, Oregon Cascade Mountains, Oregon Coast Ranges, and Klamath Mountains of Oregon and California) provides compelling evidence that a population bottleneck may have occurred, with more prominent bottlenecks in the Washington Cascade Mountains as compared to other regions in the analysis (Funk et al. 2010).

Since the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two species have resulted as well. The majority of hybrids that have been evaluated with genetic methods have resulted from a cross between a female Barred Owl and a male Spotted Owl (Haig et al 2004b, Kelly and Forsman 2004). First generation hybrids share phenotypic and vocal characteristics of both parent species (Hamer et al. 1994). Second generation hybrids are often difficult to distinguish from Barred or Spotted Owls in the field and genetic testing may be the only sure method of identification (Kelly and Forsman 2004). Both first and second generation hybrids were found to be reproductively viable in some cases (Kelly and Forsman 2004).

Geographic Range and Distribution

The current range of the Northern Spotted Owl extends from southwest British Columbia through the Cascade Range, coastal ranges, and intervening forested lands in Washington, Oregon, and northern California, as far south as Marin County (USFWS 1990). The transition between subalpine to alpine forests marks the upper elevation limit at which Northern Spotted Owls are known to occur (Forsman 1975, Forsman et al. 1984). Prior to the mid-1800s, Northern Spotted Owls are believed to have inhabited most old-growth forests or stands throughout the Pacific Northwest, including northwestern California (USFWS 2011a). Although the overall range is not known to have changed, the Spotted Owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon (USFWS 2011a). Local declines have been observed in many portions of the range (see Status and Trends and Barred Owl sections of this report).

The range has been partitioned into 12 physiographic provinces based on landscape subdivisions with different environmental features (Thomas et al. 1990) (Figure 1). This total range of the Northern Spotted Owl has been estimated to have an extent of 230,690 km² (57 million acres) (USDA and USDI 1994).

The 12 physiographic provinces are distributed across the species' range as follows:

- Four provinces in Washington: Eastern Washington Cascades, Olympic Peninsula, Western Washington Cascades, Western Washington Lowlands

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- 359 • Five provinces in Oregon: Oregon Coast Range, Willamette Valley, Western Oregon Cascades, Eastern Oregon Cascades, Oregon Klamath
- 360 • Three provinces in California: California Coast, California Klamath, California Cascades

361 In California, the Northern Spotted Owl range runs south as far as Marin County in the Coast Ranges and across the Klamath Mountains of
362 northern California east to the Cascade Range where it meets the range of the California Spotted Owl (*S. o. occidentalis*) near the Pit River
363 (Figure 2). The California Coast Province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of
364 national forest lands. The California Klamath Province is between the California Coast Province to the west and the California Cascades province
365 to the east, and is a continuation of the Oregon Klamath province, with a southern boundary at the Clear Lake Basin in the inner Coast Range.
366 The California Cascades province is bounded on the west by the Sacramento Valley and the Klamath Mountains, on the east by the Modoc
367 Plateau and Great Basin, and to the south by the Sierra Nevada Mountains (USFWS 1992, Courtney et al. 2008).

368 Broad-scale patterns of relative abundance of Spotted Owls are suggested by the distribution of recorded Northern Spotted Owl activity centers
369 across the landscape. An activity center is a known Northern Spotted Owl site documented from survey detections (See Appendix 2 for a more
370 detailed definition of activity center). Lower interior densities of Northern Spotted Owl are acknowledged in the 2011 Recovery Plan (USFWS
371 2011a), which states, "...the dry forest portion of the Spotted Owl's range hosts a minority of the overall population..." Records from the
372 Department's Spotted Owl Database indicate that generally activity centers occur at lower densities in the drier portions of the interior Klamath
373 and Cascade ranges, compared to the Coastal Range and wetter portions of the Klamath Province (Figure 3). It appears many activity centers
374 within the Coast Province have been documented only beginning in the 1990s. This is likely due largely to increased survey effort by private
375 timber companies following the listing by the federal government rather than an increase in Spotted Owl territories in the Coast Province,
376 although Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property in Humboldt and
377 Del Norte counties that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature
378 (GDRC 2015). Humboldt Redwood Company has also reported an increase in number of sites since 2008, but acknowledges the possibility that
379 the increase may be due to the displacement of Spotted Owls to new sites as a result of increasing numbers of invasive Barred Owls (HRC 2015).
380 Large timber companies in the coastal portion of the range have identified a large number of activity centers on their ownerships, with more
381 than 200 activity centers on some ownerships. Consistent with the general pattern, private ownerships in the interior have lower densities of
382 Northern Spotted Owls, but some timber companies still host close to a hundred activity centers (Calforests 2014). Caution must be used when
383 examining these data; activity center sites do not represent the actual number or density of owls across the range in California due to the nature
384 the data are collected and reported. Data are often collected inconsistently based on local project-level monitoring needs and not all data is
385 reported to the database. Also, activity centers are generally retained in the database over time regardless of annual occupancy status (see
386 Status and Trends section of this report).

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387 *Reproduction and Development*

388 The Northern Spotted Owl is relatively long-lived with a long reproductive life span (Forsman et al. 1984, Gutiérrez et al. 1995), with wild owls
389 living up to 20 years. Owls are reproductively mature at 1 year of age, but generally do not reproduce for the first time until 2 to 5 years of age.
390 Courtship initiates in February or March, with the first eggs laid in late March through April (Miller et al. 1985, Franklin 1992, Forsman et al.
391 2002). Timing of breeding onset varies by latitude and elevation, with delayed nesting occurring at higher elevations and latitude (Forsman et al.
392 1993). Females typically lay 1 to 4 eggs per clutch, with 2 eggs per clutch most common (Forsman et al. 1984, USFWS 1990, Anthony et al. 2006).
393 Incubation, performed exclusively by the female, lasts about 30 days (Courtney et al. 2004). Brooding is almost constant for the first 8 to 10 days
394 and is also done exclusively by the female, after which the female will take short trips off of the nest to hunt (Courtney et al. 2004). The male
395 provides all the food to the nest during incubation and the first 10 days of brooding (Courtney et al. 2004). Chicks fledge from the nest in late
396 May or in June and continue to be dependent on their parents into September until they are able to fly and hunt for food on their own (Forsman
397 et al. 1984, USFWS 1990). Adults can typically be found roosting with young during the day for the first few weeks after they leave the nest, after
398 which adults typically only visit their young during the night to deliver food (Forsman et al. 1984). By November, most juveniles begin to disperse
399 (Miller et al. 1997, Forsman et al. 2002, Courtney et al. 2004).

400 Most Spotted Owls do not breed every year, but more normally breed every other year (Forsman et al. 2011). The reason for this biennial
401 breeding pattern is unknown, but may be due to the large time investment and energy cost to produce young (Forsman et al. 2011). Annual
402 variation in reproductive success is thought to be related to weather conditions and fluctuations in prey abundance, but may also be related to
403 individual variation, age, and habitat quality within the territory (Forsman et al. 1993, Forsman et al. 2011). Small clutch size, temporal variation
404 in nesting and nest success, and long onset of breeding maturity all contribute to low fecundity for the Northern Spotted Owl (Gutiérrez 1996).

405 *Density*

406 Density (i.e., number of individuals per unit of area) estimates for Northern Spotted Owl are difficult to obtain due to the level of effort required
407 to survey all potential habitat in a given area. Density has been estimated for specific study areas, but not across the species' entire range;
408 several estimates of density are available from sites in California (Table 1). Franklin et al. (1990) estimated crude density (territorial owls/km²) of
409 owls in the Willow Creek Study Area, Humboldt County, at 0.235 owls/km² (95% CI = 0.214-0.256), and ecological density (number of
410 individuals/ km² of habitat) at 0.544 owls/km² (95% CI = 0.495-0.592) and 0.660 owls/km² (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995)
411 estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km². Diller and Thome (1999) estimated crude density for owls
412 in their northern California coast study area in Humboldt, Trinity and Del Norte counties to be 0.092 owls/km²±0.006, 0.351 owls/km²±0.011,

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and 0.313 owls/km²±0.017 for Klamath, Korbelt and Mad River regions respectively, with an overall mean density of 0.209 owls/km²±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbelt, and Mad River respectively (Diller and Thome 1999). The 2015 annual report for Green Diamond Resource Company Northern Spotted Owls Habitat Conservation Plan (GDRC 2015) notes a density of 0.17 owls/km² in the northern portion of their land in Humboldt County, and 0.78 owls/km² in southern portions. Sierra Pacific Industry reported 0.450 owls/km² between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km² between 2011 and 2013 on their lands in Trinity, Siskiyou, Shasta, Modoc and Lassen counties (Roberts et al. 2015). In Mendocino County, Mendocino Redwood Company reported a density of 1.89 occupied territories/km² of area surveyed (MRC 2014). Lastly, Humboldt Redwood Company (HRC) reported 1.22 occupied territories/km² and 2.23 owls/km² of area surveyed on their lands in Humboldt County (HRC 2013).

Table 1. Density estimates for Northern Spotted Owls within various study areas throughout the range in California.

Source	Density Measure	Location
Franklin et al. 1990	0.235 territorial owls/km ² 0.544 number of owls/ km ² of habitat 0.660 number of owls/ km ² of habitat	Willow Creek Study Area in Humboldt County
Tanner and Gutiérrez1995	0.219 owls/km ²	Redwood National Park in Humboldt County
Diller and Thome 1999	0.092 owls/km ² (Klamath) 0.351 owls/km ² (Korbelt) 0.313 owls/km ² (Mad River) 0.209 owls/km ² (mean)	Northern California coast study area in Humboldt, Trinity and Del Norte counties
GDRC 2015	0.170 owls/km ² (northern) 0.780 owls/ km ² (southern)	Green Diamond Resource Company land in Humboldt County
Roberts et al. 2015	0.450 owls/km ² between 1989 and 2003 0.450 owls/km ² between 2003 and 2007 0.459 owls/km ² between 2011 and 2013	Sierra Pacific Industry lands in Trinity, Siskiyou, Shasta, Modoc and Lassen* counties
MRC 2014	1.89 occupied territories/km ² of area surveyed	Mendocino Redwood Company in Mendocino County
HRC 2013	1.22 occupied territories/km ² of area surveyed 2.23 owls/km ² of area surveyed	Humboldt Redwood Company in Humboldt County

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* Densities were reported for Modoc and Lassen counties in this study; however these counties are not within the range of the Northern Spotted Owl. Sierra Pacific Industry lands in this study overlap with the Northern Spotted Owl and California Spotted Owl ranges.

As apparent from the reports of density estimates above, there is considerable variation among studies even though most studies occurred within the coastal forests. This variation in density may be attributed to habitat availability, habitat heterogeneity, territoriality, weather patterns, and presence of invasive Barred Owls (Franklin et al. 1990, Diller and Thome 1999, Courtney et al. 2004 Sovern et al. 2014). Another possible explanation of the variation is that data collection and analysis varied among the studies. Given this, it is nearly impossible to extrapolate density across the entire California range for Northern Spotted Owl.

Hunting and Food Habits

As described in Forsman et al. (1993), Northern Spotted Owls are sit and wait (e.g., perch and pounce) predators. They mostly hunt during nighttime hours (i.e., nocturnal), but will forage during the day as well (Forsman et al. 1984, Sovern et al. 1994, Forsman et al. 2001). Generally, flying squirrels are the main component of the diet in Douglas-fir and western hemlock forest within the northern portion of the owl's range (in Washington and Oregon); whereas in the southern portion of the range (Oregon Klamath, California Klamath, and California Coastal Provinces) dusky-footed woodrats are the main component of the diet (Forsman et al. 1984, 2001, 2004, Zabel et al. 1995, Ward et al. 1998, Franklin et al. 2000, Hamer et al. 2001, Dugger et al. 2005). Other prey items seen in the owl's diet in smaller proportions include deer mice, tree voles, red-backed voles, gophers, snowshoe hare, bushy-tailed woodrats, small to medium sized birds, bats, and insects (Forsman et al. 1984, 2001, 2004, Ward et al. 1998, Hamer et al. 2001). A study within the Southern Cascades and Klamath Provinces in California (Timber Products Company timberland) identified 16 species of mammals, 5 species of birds, and 1 species of insect among 224 pellets collected, with major prey items being 58.3% woodrat sp., 29.2% Northern flying squirrel, 3.9 % broadfooted mole, 3.9% rabbit and 1.4% gopher (Farber and Whitaker 2005).

Diet analysis conducted in Washington during the fall and winter months indicated seasonal variation in prey species consumed as a function of the availability of the owls preferred prey species during various portions of the year (Forsman et al. 2001). In the Washington study area, flying squirrels were more prevalent in the diet during fall and winter months, whereas prey species that hibernated or spent the winter under the snow (e.g., chipmunks and pikas) were missing from the diet during the same period. During the spring, summer and early fall months consumption of insects, gophers, and snowshoe hares occurred more frequently (Forsman et al. 2001). Forsman et al. (2001) noted that diets varied among territories even within the same forest type with much of the variation attributed to differences in spatial abundance of prey, but other factors, such as individual preferences, experience, prey accessibility, or timing of pellet collection, may have played a role. While the populations in California are geographically distinct, and hunting and food habits may differ somewhat from owls in Washington, Northern Spotted Owls in California likely vary diet seasonally according to the spatial distribution and abundance of their preferred prey.

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449 Metabolic measurements made on California Spotted Owls in Weathers et al. (2001) showed very low basal metabolic rates compared to other
450 owl species, thereby leading to very low energy requirements. Field metabolic rate on adults actively caring for young averaged only 34% of the
451 metabolic rate predicted for other avian species of the same size (Weathers et al. 2001). Considering this low metabolic rate, Weathers et al.
452 (2001) found that, on average, owls can meet their energy requirements by consuming one northern flying squirrel every 1.8 days or one
453 woodrat every 3.7 days. This low metabolic requirement is likely similar to that of Northern Spotted Owls, though no known study has been
454 conducted on this subspecies.

455 There is strong evidence that prey abundance and availability affect selection and use of habitat and home range size of Northern Spotted Owls
456 across their range (Zabel et al. 1995). In northwest California, Northern Spotted Owls were found to forage in areas where the occurrence of
457 prey was more predictable, within older forests, and near ecotones of old forest and brush seral stages (Ward 1990 as cited in USFWS 2011a).
458 Owls tend to select old-growth forests with less edge habitat and have larger home ranges when flying squirrels are the dominant prey, whereas
459 they tend to select variable-aged stands with more edge habitat when woodrats are the dominant prey (Courtney et al. 2004). In these variable-
460 aged stands, older forests remain an important component of nesting and roosting habitat. Where woodrats are the dominant prey, the amount
461 of edge between older forests and other habitat types in Oregon was found to have a positive effect on foraging success and subsequent
462 reproductive success due to increased prey availability (Olson et al. 2004). Where woodrats are the primary prey item, young seral stages often
463 provide high quality prey habitat but provide limited foraging opportunities for Spotted Owls due to a lack of perches from which to hunt or to
464 prey inaccessibility in the dense undergrowth; however, when young seral forests are adjacent to older forest stands surplus woodrats may
465 disperse into these older forests making them more vulnerable to predation by Spotted Owls (Meyer et al. 1998, Franklin et al. 2000, Zabel et al.
466 2003, Olson et al. 2004). In the northwestern California coast redwood zone and the mixed conifer forests in the interior of the California range
467 near Yreka, California, studies have shown that Spotted Owls will forage in recent harvest-created hardwood and shrub habitat (i.e., within 6-30
468 year old clearcuts) that contain woody debris, scattered conifers and snags, and that are adjacent to older forests (Irwin et al. 2013). Winter use
469 of these areas was more pronounced in areas with 9-18 m²/ha basal area (Irwin et al. 2013).

470 *Home Range, Core Use Areas and Territoriality*

471 Northern Spotted Owls are territorial. Territories are actively defended using aggressive vocal displays, and even physical confrontations on the
472 rare occasion (Courtney et al. 2004). Because of their high territoriality, broadcast surveys are generally a very effective method for determining
473 presence of Spotted Owls (Courtney et al. 2004); however, calling may be suppressed by the presence of Barred Owls (see Barred Owl section of
474 this report). Territory size for Northern Spotted Owls varies depending on the setting and structure of the habitat (e.g., canopy closure,
475 understory composition, and slope), number of available nesting and roosting sites, and location relative to suitable foraging habitat (Courtney
476 et al. 2004). In general, Spotted Owls have a broad home range with a centrally located nest and roosting site. For this reason, Spotted Owls are

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477 considered central place foragers during the breeding season when they are tied to a central nesting or roosting site. Spotted Owls often occupy
478 a home range that is larger than the core use area, and may use an area that is larger than the portion of the home range which is defended (i.e.,
479 home ranges may overlap with that of other Spotted Owls). Northern Spotted Owl home ranges generally have a greater amount of older forest
480 near the nest and within the core area use, and more diverse forest types and ages on the periphery of their ranges (Swindle et al. 1999, Hunter
481 et al. 1995).

482 Estimates of annual home range size vary across the Northern Spotted Owl's range. The 1990 Conservation Strategy for Northern Spotted Owls
483 (Thomas et al. 1990) reports median annual home range size of owl pairs in various study areas throughout the species' range. Table 2
484 summarizes home range estimates across the range of the Northern Spotted Owl. Home range estimates from various studies are reported using
485 different analytical tools (e.g., Minimum Convex Polygon, Modified Minimum Convex Polygon, Fixed Kernel, and Adaptive Kernel) and are
486 identified as such in Table 2. Median home range sizes in Oregon and Washington varied from a low of 1411 acres in the mixed conifer forests of
487 the Klamath Mountains (South Umpqua) to a high of 9930 acres in Washington's Olympic Peninsula, consisting mostly of western hemlock with
488 Douglas-fir (Thomas et al. 1990). More recently, Schilling et al. (2013) documented considerably smaller home range sizes in southwestern
489 Oregon's mixed conifer forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference between breeding
490 and nonbreeding seasons. The study showed core area size, annual home range and breeding home range size increased as amount of hard edge
491 increased (Schilling et al. 2013). In their study site in the dry forests of the eastern Cascades in Washington, Forsman et al. (2015) found
492 considerable difference between breeding home range and non-breeding home range, with ranges being 3.5 times larger during the fall and
493 winter months.

494 Home range of Northern Spotted Owls may overlap with those of other neighboring owl pairs, suggesting that the defended area (i.e., territory)
495 is smaller than the area used for foraging (Forsman et al. 1984, Solis and Gutiérrez 1990, Forsman et al. 2015). Northern Spotted Owl home
496 ranges are larger where flying squirrels are the predominant prey, in the northern portion of the range, and smaller where woodrats are the
497 predominant prey, in the southern portion of their range (Zabel et al. 1995, Forsman et al. 2001). Woodrats provide twice the biomass of flying
498 squirrels and therefore are more energetically favorable, which likely explains the smaller home range in the owl's southern portion of the range
499 (Ward et al 1998, Franklin et al. 2000). The portion of the home range used during the breeding season can be significantly smaller than that
500 used in the remainder of the fall and winter (Forsman et al. 1984, Sisco 1990 as cited in USFWS 2011a, Forsman et al. 2015). Forsman et al.
501 (2015) attributes the larger winter home range to prey dynamics and exploratory excursions in search of better habitat.

502 Like many other animals, Northern Spotted Owls exhibit selective behavior by utilizing certain areas with their home range more intensively than
503 others (Bingham and Noon 1997). These areas of disproportionate use, termed core use areas, commonly include nest and roosting sites and
504 access to dependable food sources. Bingham and Noon (1997) used breeding-season owl telemetry relocations and an adaptive kernel

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algorithm and found that Northern spotted owls spent 60 to 75% of their time in their core use areas. The mean core use area size for Northern Spotted Owl pairs in the Klamath Province was 166 ha (SE=26 ha, range=68-184 ha). Adding one standard error to the mean size of pairs' core area that they found, and assuming a circular shape for the purpose of evaluating and managing habitat, a core use area of this size would have a radius of 0.49 mile. Carey and Peeler (1995) had similar findings outside the Klamath Province, in southern Oregon.

Disproportionate use of core areas is likely influenced by territoriality in Northern Spotted Owls, and the area of a defended territory is likely a good scale at which to evaluate and manage habitat since it contains needed resources and is defensible. Observed territorial spacing of Northern Spotted Owls provides additional support for using a 0.5-mile-radius core use area for habitat management purposes. Half the nearest neighbor distance can be used to estimate the size of the defended portions of the home ranges. Half the mean and median nearest neighbor distances for nesting Northern Spotted Owls were 0.49 mile (Hunter et al. 1995) and 0.44 mile (Franklin et al. 2000), respectively. Additional support for the validity of managing habitat within core use areas estimated as a 0.5-mile-radius area around activity centers is provided by studies that modeled habitat-fitness (Franklin et al. 2000, Dugger et al. 1995) and presence (Zabel et al. 2003). These studies found that important Northern Spotted Owls habitat relationships were well captured at scales of 0.44 to 0.50 mile.

Table 2. Summary of annual home range and core home range sizes across the range of the Northern Spotted Owl. MCP = Minimum Convex Polygon, MMCP = Modified Minimum Convex Polygon, FK = Fixed Kernel, and AK = Adaptive Kernel.

Area	Annual Home Range in hectares (+/- one Standard Error)				Core area in hectares	Source
	MCP	MMCP	95% FK	95% AK		
Oregon Coast	1569(463)	1018(160)				Carey et al. 1992
Oregon Coast	1108(137) to 2214(357)		842(115) to 1344(247)		87(6) to 100(5) 95% FK	Glenn et al. 2004
Oregon Coast	2272 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
Oregon Coast	2586 (median)					Thraikill and Meslow pers comm. (as reported in Thomas et al. 1990)
Oregon Coast	1693 (median)					Carey et al. 1990 (as reported in Thomas et al. 1990)
Oregon Klamath	533(58)	472(43)				Carey et al. 1992
Oregon Klamath			576(75)		94(11) 95% FK	Schilling et al. 2013

Comment [JEH2]: Table may need editing in light of core use area data above.

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Oregon Western Cascades	3066(1080)				417(129) AK	Miller et al. 1992
Washington Eastern Cascades	3419(826)		2427(243)			Forsman et al. 2015
Washington Eastern Cascades	3669(876)					King 1993
Washington Western Cascades	2553 (median)					Various references as reported in Thomas et al. 1990
Washington Olympic Peninsula	4019 (median)					Various references as reported in Thomas et al. 1990
California Klamath	1204 to 1341 (median)					Paton et al. 1990 (as reported in Thomas et al. 1990)
California Klamath	685 (median)					Solis 1983 (as reported in Thomas et al. 1990)
California Coast	786(145)			685(112)	98(22) 95% AK	Pious 1995

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519 *Dispersal*

520 As discussed above, juveniles begin to disperse in the fall, with a few individuals beginning to disperse in
521 early winter. Juvenile dispersal from the parental territory occurs in stages, as juveniles may temporarily
522 settle in locations for up to 7 months before moving on to another temporary location, which may occur
523 several times before individuals establish a territory of their own (Miller et al. 1997, Forsman et al.
524 2002). By late October, most young Northern Spotted Owls have dispersed from the natal area
525 (Gutiérrez et al. 1985). LaHaye et al. (2001) found that successful juvenile California Spotted Owls often
526 settled in territories previously used by pairs or single owls, which may suggest that owls were able to
527 use some sort of cues that indicated some value of habitat quality when determining a territory of their
528 own (Buchanan 2004).

529 In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent
530 territory was between 13.5 and 14.6 km (8.4-9.1 mi) for males and between 22.9 and 24.5 km (14.2-15.2
531 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted
532 Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while
533 juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). While the only
534 data available on dispersal pertains to Northern Spotted Owls in Washington and Oregon, and California
535 Spotted Owls in California, we can extrapolate that Northern Spotted Owls in California act similarly,
536 because, while the populations are genetically and geographically distinct, they still share many
537 ecological and behavioral characteristics.

538 Juvenile Northern Spotted Owls experience high mortality rates (>70% in some areas) during dispersal
539 due to a variety of factors including starvation, predation, and vehicle strikes (Miller 1989, Franklin et al.
540 1999, USFWS 1990, Forsman et al. 2002). Habitat type used during dispersal may also have an effect on
541 mortality. Miller et al. (1997) found that the probability of mortality decreased when dispersing
542 juveniles utilized open sapling forests, but increased when clear cuts were utilized. Successful juvenile
543 dispersal likely depends on locating suitable nesting, roosting and foraging habitat in proximity to other
544 occupied sites or among occupied sites (LaHaye et al. 2001), as well as the presence of suitable habitat
545 to disperse through (Miller et al. 1997, Buchanan 2004).

546 **Habitat Requirements**

547 Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western
548 hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and
549 redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally
550 use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al.
551 1990, Carroll and Johnson 2008, Carroll 2010, USFWS 2011); however, younger forest stands with
552 structural components similar to older forests may also be used by Spotted Owls (USFWS 2011a). The
553 edge between old-growth forest and other vegetation types have also been shown to be an important
554 habitat ~~components~~ feature (Franklin et al. 2000).

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Throughout the Northern Spotted Owl's range in Washington, Oregon, and California, Bart and Forsman (1992) found owls were about 40 times more common in areas with older forest compared to areas lacking older forest. In Western Oregon, Meyer et al. (1998) determined that random owl sites contained more old-growth forest than random locations on the neighboring landscape. In Northwestern California, Northern Spotted Owls used old-growth with a higher frequency relative to this forest age class' distribution on the landscape, and similarly, used intermediate to young forests with a lower frequency (Solis and Gutiérrez 1990 and Thome et al. 1999).

Discussions on habitat components below address range-wide knowledge of Northern Spotted Owl habitat, as well as knowledge of owl habitat specific to California. This report addresses habitat requirements with a focus on major geographic provinces in California. When considering the enormous amount of research on Northern Spotted Owl habitat, careful consideration should be given to California-specific research when evaluating habitat requirements for the species in the state, and in forming conservation and management decisions.

Nesting and Roosting Habitat

Habitat selection has largely been evaluated for nesting and roosting habitat by comparing habitat surrounding occupied Spotted Owl sites to randomly selected sites (Solis and Gutiérrez 1990, Bart and Forsman 1992, Hunter et al. 1995, Thome et al. 1999). Descriptions of nesting and roosting habitat were provided in the early- to mid- 1990s (Solis and Gutiérrez 1990, Thomas et al. 1990, Bart and Forsman 1992) and have been validated by extensive research across most of the range of Northern Spotted Owl (Gutiérrez et al. 1995, Hunter et al. 1995, Meyer et al. 1998, Lahaye and Gutiérrez 1999, Swindle et al. 1999, Weathers et al. 2001, Courtney et al. 2004, USFWS 2008a, USFWS 2011a).

The following description of nesting and roosting habitat from the Conservation Strategy for the Northern Spotted Owl (Thomas et al. 1990) remains an accurate portrayal of what we know today throughout the range of the owl:

"With the exception of recent studies in the coastal redwoods of California, all studies of habitat use suggest that old-growth forests are superior habitat for northern Spotted Owls. Throughout their range and across all seasons, spotted owls consistently concentrated their foraging and roosting in old-growth or mixed-age stands of mature and old-growth trees. Exceptions were found, but even they tended to support the usual observations that spotted owls nested in stands with structures characteristic of older forests....Structural components that distinguish superior spotted owl habitat in Washington, Oregon, and northwestern California include: a multilayered, multispecies canopy dominated by large (>30 inches dbh) conifer overstory trees, and an understory of shade-tolerant conifers or hardwoods; a moderate to high (60-80 percent) canopy closure; substantial decadence in the form of large, live coniferous trees with deformities- such as cavities, broken tops, and dwarf mistletoe infections; numerous large snags; ground cover characterized by large accumulations of logs and other woody debris; and a canopy that is open enough to allow owls to fly within and beneath it."

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Although this habitat description accurately describes high quality nesting and roosting habitat throughout the range of the Northern Spotted Owl, recent research has shown that Spotted Owls in California and portions of southwest Oregon use a more diverse set of forest types for foraging. This is described more fully in the Foraging Habitat section of this report.

Forested stands with a higher degree of complexity and a high canopy closure are thought to be preferred for nesting and roosting, in part, because they provide protection from predators and thermal exposure (Weathers et al. 2001, Franklin et al. 2000). Hunter et al. (1995) determined nest and roost sites occurred more frequently in mature and old-growth forest in northwestern California (Willow Creek Study Area) relative to availability of these forest types' on the landscape. Both nest and roost sites had similar amounts of mature and old-growth forest types. Whereas sites used for nesting and roosting in the coastal forests of California often contain younger trees than more interior nesting and roosting sites. In the California Coast Province, young redwood forests along the coast have structural complexity similar to that of older forests elsewhere in the Northern Spotted Owl's range. This is due to stump-sprouting and the rapid growth rates of redwoods, together and variable timber management practices (Thomas et al. 1990, Thome et al. 1999, USFWS 2011a, Irwin et al. 2013).

Small-scale spatial habitat requirements in the immediate vicinity of the nest are important but not sufficient to support all activities (e.g., roosting and foraging) conducted at the larger spatial scale (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, USFWS 2011a). Consequently, nesting and roosting habitat is often only a small portion of the entire home range (Forsman et al. 1984, Solis and Gutiérrez 1990, USFWS 2011a).

To assess the success of the coordinated forest management plan for federal lands, the Northwest Forest Plan (NWFP; see Northwest Forest Plan section of this report), Davis et al. (2011) developed a habitat suitability map for nesting and roosting habitat across the Northern Spotted Owl range (Figure 4). The habitat suitability model was developed using MaxEnt model output, including variables for percent conifer cover, average conifer dbh, amount of large conifer (trees >30 in dbh per acre), diameter diversity, average stand height, and average stand age. Much of the highest suitable habitat is within northwestern California (inclusive of the northern most portion of the California Coast Province and the western portion of the California Klamath Province) and along the coastal forests.

Foraging Habitat

Compared to nesting and roosting habitat, foraging habitat occurs over a much larger portion of the Northern Spotted Owl's home range, often quite distant from the nesting or roosting site. Within a Spotted Owl home range, foraging habitat use may vary seasonally, with a larger area and younger forests used in the non-breeding period (Forsman et al. 1984, Solis and Gutiérrez 1990, USFWS 2011a). Overall foraging habitat consists of areas where the prey species occur and are available (Ward 1990, Zabel et al. 1995).

In California, foraging habitat is generally composed of a more diverse set of forest types and structural characteristics than nesting and roosting habitat. Spotted Owls are difficult to observe during nighttime

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629 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and
630 roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry
631 studies that document owl locations throughout nighttime movements. Although it is difficult to
632 determine when and where owls are actually obtaining prey, telemetry does provide information on the
633 diversity of forest types used during foraging excursions.

634 There is a general shift in foraging habitat requirements from north to south within the Northern
635 Spotted Owl range, with foraging habitat in the northern portion of the range being composed of mostly
636 older forests, and in California being composed of a diverse range of forest types from mature to
637 relatively young (USFWS 2009). In the northern portion of the Northern Spotted Owl range where flying
638 squirrels are the dominant prey, foraging habitat may have the same characteristics as nesting and
639 roosting habitat (Gutiérrez_1996, USFWS 2011a). Whereas in the southern portion of their range, where
640 woodrats and voles are the predominant prey species, foraging habitat may include tanoak, oak and
641 younger conifer stands that provide a food source for these prey species (Franklin et al. 2000, USFWS
642 2009).

643 Landscape-level analyses in portions of the Klamath Province, where woodrats are the main prey item,
644 suggest that a mosaic of late-successional forests intermixed with various other seral stages may benefit
645 Northern Spotted Owls more than large uniform blocks of older forests (Meyer et al. 1998, Franklin et al.
646 2000, Zabel et al. 2003). Irwin et al. (2012) found in Oregon and northwestern California that Northern
647 Spotted Owl foraging habitat appeared to be maximized in patches of trees with average quadratic
648 mean diameter¹ of 40 to 55 cm (15-22 inches). Probability of an area being selected for foraging
649 declined rapidly beyond 200 to 300 m (0.12-0.19 miles) from a nest site, yet increased with basal area of
650 hardwoods and with increases in shrub counts (except in areas with high abundance of hardwoods and
651 shrubs).

652 Within the northern Sierra Nevada Mountains, similar to the mixed conifer Cascade mountain range,
653 Irwin et al. (2007) used radio-telemetry data to assess foraging use parameters of California Spotted
654 Owls. Topography, forest density and heterogeneity, and tree species composition all influenced
655 foraging habitat selection, which in this case was driven by the habitat of the preferred prey, dusky-
656 footed woodrat. Foraging was closely associated with forest stands next to nests and small streams at
657 lower elevations. Intermediate basal area values (35-55 m²/hectares) for Douglas-fir, white fir, and red
658 fir and hardwoods ≥20 cm (≥8 inches) were all positively correlated to foraging habitat use. Owls
659 foraged in sites with an average tree density of 1160 trees/hectare, foraged in stands with 17 large
660 green (>66 centimeter or >26 inch diameter) trees/ha. Use declined with increasing basal area of
661 ponderosa pine. Foraging areas were not strongly associated with roads, slope or aspect.

¹ Compared to the arithmetic mean, quadratic mean diameter, or QMD, assigns greater weight to larger trees. QMD is always greater than or equal to the arithmetic mean for diameter at breast height for a given set of trees.

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As noted previously in this report, several studies have shown a benefit of edge habitat for Northern Spotted Owls, as certain habitat types that border older forest may contain higher numbers of preferred prey, the dusky footed woodrat, and surplus prey may venture into older forests that border habitat where prey is abundant making them more available to foraging owls (Zabel et al. 1995, Thome et al. 1999, Franklin et al. 2000, Franklin et al. 2013). For instance, Zabel et al. (1995) often found Spotted Owls foraging near transitions between early- and late-seral stage forests stands in northern California, likely where prey species were more abundant or more readily available. Franklin et al. (2000) conducted a modeling effort in northwestern California to help explain variation in both apparent survival and reproductive output. The study found that one of the best models contained a covariate representing the amount of edge between Spotted Owl (defined in the study as mature and old-growth forests with particular characteristics) and other habitats, thereby suggesting that reproductive output and survival are positively influenced by amount of edge, presumably due to increased availability of prey. However, foraging owls have been shown to avoid non-forested areas (e.g., recent clearcuts) and very early forest successional stages (USFWS 2011a, Irwin et al. 2013).

Dispersal Habitat

Generally, it is well accepted that dispersal habitat for Northern Spotted Owls consists of stands with adequate tree size and canopy closure to provide protection from avian predators and that have at least minimal foraging opportunities (Miller et al. 1997, Thomas et al. 1990, Forsman et al. 2002, Buchanan 2004, USFWS 2011a). This may include younger forest stands with less diversity than nesting and roosting habitat, such as even-aged and pole stands, but should at the minimum contain some roosting structures and foraging habitat during this transient stage (Davis et al. 2011, USFWS 2011a). The latest meta-analysis (Forsman et al. 2011) indicates that recruitment of owls into the breeding population likely depends on the amount and quality of dispersal habitat to ensure survival of dispersing owls.

Spotted Owls have been shown to disperse through highly fragmented forest landscapes and seem to use mature and old-growth forests more than that forest type's availability on the landscape during this phase (Miller et al. 1997, Forsman et al. 2002). The USFWS (USFWS 2011) states that corridors of dispersal habitat within fragmented landscapes act to facilitate rapid movement to areas of better habitat. There is little evidence that small openings in forest habitat influence the dispersal of Spotted Owls, but large non-forested valleys may act as barriers to both natal and breeding dispersal (Forsman et al. 2002). Water bodies may also function as barriers to dispersal, but this is not clearly understood (Forsman et al. 2002).

Thomas et al. (1990) suggests juvenile movement corridors need not be provided on the landscape outside of areas managed as nesting and roosting habitat if 50% of the forest measured on a quarter township basis is forested by trees with average diameter >11 inches and >40 percent canopy closure (i.e., the 50-11-40 rule). Regarding this rule, the USFWS Recovery Plan (2011) states, "the minimum levels of this definition describe habitat supporting the transient phase of dispersal."

A clear understanding of dispersal habitat is key to the management of owl habitat across the Northern Spotted Owl's range. Buchanan (2004) stressed the importance of appropriate management of dispersal

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habitat and suggests that one of the greatest inadequacies of Spotted Owl habitat management is the lack of retention of structurally complex forest components, such as snags and downed woody debris, at the time of or post timber harvest. Additional studies in California, such as radio telemetry on juvenile owls, prey abundance and availability, and habitat modeling, are required in order to elucidate specific habitat requirements for and barriers to dispersal.

In an attempt to document the level of change in dispersal habitat, Davis et al. (2011) developed dispersal habitat maps for 1994-2007 using Global Information Systems (GIS), using variables for conifer dbh ≥ 11 inches and conifer cover ≥ 40 percent (Figure 5). The maps also included some amount of nesting and roosting habitat since owls will disperse through these habitat types. Dispersal habitat is continuous in large portions of the northern range in California, with small isolated patches north of Point Arena and in Marin County, in the California Coast Province.

Northern Spotted Owl Habitat Descriptions for Geographic Provinces in California

The forest types within the California range are quite diverse, and consequently, Northern Spotted Owls use the habitat differently among these forest types. Historically the range of the Northern Spotted Owl has been separated into 12 physiographic provinces based on differences in vegetation, soils, geologic history, climate, land ownership and political boundaries (USFWS 2011a; Figure 1); of which three provinces are in California – California Coast, California Klamath, and California Cascade. To better understand the range of forest types used and regional differences that influence habitat quality in California, general owl habitat within each province is described below.

In addition to province segregations, habitat modeling conducted for the 2011 Revised Recovery Plan (USFWS 2011a) identified 11 modeling regions range-wide, five of which occur in California (Figure 6). These modeling regions were developed to capture regional differences in forest environments in acknowledgement of the fact that Northern Spotted Owls exhibit different habitat associations in various portions of their range, and focused on differences in habitat rather than political boundaries or ownership type. For this reason, four of the five modeling regions in California extend into Oregon where similar habitat occurs. Modeling regions that overlap with the California Coast, California Klamath and California Cascade provinces are described below under the appropriate province description.

California Coast Province

A description of the California Coast province is noted below, as defined in the 1992 Northern Spotted Owl recovery plan (USFWS 1992):

“The California Coast province extends from the Oregon border to San Francisco Bay and from the ocean to the western border of national forest lands. The coastal part of the province encompasses the majority of the redwood forest habitat type. Inland forests are Douglas-fir and mixed Douglas-fir/hardwood types, the latter often interspersed with chaparral and grasslands.”

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Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) are included in the California Coast Province, the Redwood Coast (RDC) and Interior Coast (ICC) regions. The RDC is described below:

“This region is characterized by low-lying terrain (0 to 900 m) with a maritime climate; generally mesic conditions and moderate temperatures. Climatic conditions are rarely limiting to Spotted Owls at all elevations. Forest communities are dominated by redwood, Douglas-fir-tanoak forest, coast live oak, and tanoak series. The vast majority of the region is in private ownership, dominated by a few large industrial timberland holdings. The results of numerous studies of Spotted Owl habitat relationships suggest stump-sprouting and rapid growth rates of redwoods, combined with high availability of woodrats in patchy, intensively-managed forests, enables Spotted Owls to maintain high densities in a wide range of habitat conditions within the Redwood zone. This modeling region contains the Green Diamond and Marin DSAs [density study areas].” (USFWS 2011a, pg C-9 and C-10).

Along the coast of northwestern California young redwood and mixed conifer-hardwood stands appear capable of supporting higher densities of Spotted Owls than younger forests in other regions. This is particularly the case in areas where young hardwood forests provide a multilayered structure (Thomas et al. 1990, Diller and Thome 1999) within a conifer stand. It is important to note here (and is discussed later in the document) that density estimates are not necessarily linked with high quality habitat (i.e. habitat conferring high reproductive success).

In young growth coastal forests with a negligible amount of old-growth stands (>200 yr) in Humboldt and Del Norte counties, Thome et al. (1999) found Northern Spotted Owls were positively associated with middle-aged stands (21-40 years-old) that contained larger trees and higher proportions of stands with the largest basal area class (>69 m²/ha), and negatively associated with younger stands that contained smaller trees. Irwin et al. (2013) found that Northern Spotted Owls used patches with more large trees and greater basal area within two study areas in the coastal redwood zone (Fort Bragg and Eureka). It is thought that stump-sprouting and rapid growth rates of redwoods, together with readily available high productivity of prey populations (mainly woodrats) and patchy intensively managed stands (e.g., small-patch clearcuts and residual old trees), allows owls to occupy this habitat in higher densities (Thomas et al. 1990, USFWS 2011a). Significantly cooler summer temperatures in coastal forests as compared to high summer temperatures in interior forests also likely result in higher suitability of younger redwood stands as compared to younger inland stands. Being a boreal species, Spotted Owls are heat-intolerant and select cool summer roost sites to help thermoregulate (Barrows 1981). Thome et al. (1999) found that timber management using clearcuts was associated with low reproduction, and therefore recommended clearcuts be restricted to 1.1 km (0.68 mi) beyond the nest site.

The ICC differs strikingly from the adjacent coastal redwood region, and is described below:

“This region... differs markedly from the adjacent redwood coast region. Marine air moderates winter climate, but precipitation is limited by rain shadow effects from steep elevational gradients (100 to 2,400 m.) along a series of north-south trending mountain ridges. Due to the

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772 influence of the adjacent Central Valley, summer temperatures in the interior portions of this
773 region are among the highest within the Spotted Owl's range. Forest communities tend to be
774 relatively dry mixed conifer, blue and Oregon white oak, and the Douglas-fir-tanoak series.
775 Spotted Owl habitat within this region is poorly known; there are no DSAs and few studies have
776 been conducted here. Spotted Owl habitat data obtained during this project suggests that some
777 Spotted Owls occupy steep canyons dominated by live oak and Douglas-fir; the distribution of
778 dense conifer habitats is limited to higher-elevations on the Mendocino National Forest."
779 (USFWS 2011a, pg C-12, C-13)

780 The southern limit of the owl's range in Marin County (part of the California Coast Province and inclusive
781 of both RDC and ICC regions) contains coast redwood, Bishop pine (*Pinus muricata*) and Douglas-fir
782 forests and mixed evergreen-deciduous hardwood forests (e.g., California bay, tanoak and coast live
783 oak) which are regularly used by Spotted Owls (Jenson et al. 2006, USFWS 2011a). Stralberg et al. (2009)
784 found that owls inhabiting Marin County mixed forests were equally likely to be found in conifer
785 dominated stands as they were to be found in hardwood dominated stands, and were negatively
786 affected by habitat fragmentation, yet there did not seem to be a preference for any one tree species
787 when considering owl nest site occurrence. The higher densities of owls and high reproductive success
788 in Marin County may be an indication of a more generalist nature of Marin owls when it comes to
789 habitat selection and the high abundance of woodrats in this area, in contrast to other areas within the
790 Northern Spotted Owl's range in California (Press et al. 2012). The higher use of nest platforms (rather
791 than nest cavities) in the Marin County population is similar to the ratio seen in other younger aged
792 forests, such as in the eastern Cascade Mountains in Washington (Jenson et al. 2006). LaHaye and
793 Gutiérrez (1999) suggested nest type selection depends on the age of the forest, which is supported for
794 the Marin County population where both logging and fire have resulted in younger-aged forests (Jenson
795 et al. 2006).

796 California Klamath Province

797 A description of the California Klamath province is noted below, as defined in the 1992 Northern
798 Spotted Owl recovery plan (USFWS 1992):

799 "The California Klamath province is between the California Coast province and the California
800 Cascades province. It is a continuation of the Oregon Klamath province, south to the Clear Lake
801 Basin in the inner Coast Range. The area is mountainous and covered primarily with Douglas-fir
802 forests. Mixed Douglas-fir/pine forests are common at lower elevations with Douglas-fir/true fir
803 forests at higher elevations."

804 Two modeling regions described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) make
805 up the majority of the California Klamath Province, the Western Klamath (KLW) and Eastern Klamath
806 (KLE) regions. The ICC modeling region, which is described above, represents a relatively small southern
807 portion of the California Klamath province. The KLW is described below:

808 "A long north-south trending system of mountains (particularly South Fork Mountain) creates a
809 rain shadow effect that separates this region from more mesic conditions to the west. This

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810 region is characterized by very high climatic and vegetative diversity resulting from steep
811 gradients of elevation, dissected topography, and the influence of marine air (relatively high
812 potential precipitation). These conditions support a highly diverse mix of mesic forest
813 communities such as Pacific Douglas-fir, Douglas-fir tanoak, and mixed evergreen forest
814 interspersed with more xeric forest types. Overall, the distribution of tanoak is a dominant
815 factor distinguishing the Western Klamath Region. Douglas-fir dwarf mistletoe is uncommon and
816 seldom used for nesting platforms by Spotted Owls. The prey base of Spotted Owls within the
817 Western Klamath is diverse, but dominated by woodrats and flying squirrels. This region
818 contains the Willow Creek, Hoopa, and the western half of the Oregon Klamath DSAs.” (USFWS
819 2011a, pg C-12)

820 The KLE differs from KLW by the reduced influence of marine air and a slightly varying forest
821 composition. The KLE is described below:

822 “This region is characterized by a Mediterranean climate, greatly reduced influence of marine
823 air, and steep, dissected terrain. Franklin and Dyrness ([1973]) differentiate the mixed conifer
824 forest occurring on the “Cascade side of the Klamath from the more mesic mixed evergreen
825 forests on the western portion (Siskiyou Mountains), and Kuchler (1977) separates out the
826 eastern Klamath based on increased occurrence of ponderosa pine. The mixed
827 conifer/evergreen hardwood forest types typical of the Klamath region extend into the southern
828 Cascades in the vicinity of Roseburg and the North Umpqua River, where they grade into the
829 western hemlock forest typical of the Cascades. High summer temperatures and a mosaic of
830 open forest conditions and Oregon white oak woodlands act to influence Spotted Owl
831 distribution in this region. Spotted Owls occur at elevations up to 1768 m. Dwarf mistletoe
832 provides an important component of nesting habitat, enabling Spotted Owls to nest within
833 stands of relatively younger, small trees. The western half of the South Cascades DSA and the
834 eastern half of the Klamath DSA are located within this modeling region.” (USFWS 2011a, pg C-
835 12)

836 As mentioned above, Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) provides an important
837 component of nesting habitat, enabling Northern Spotted Owls to nest within stands of relatively
838 younger small trees (USFWS 2011a). Its distribution coincides with the distribution of Douglas-fir from
839 southern British Columbia to central Mexico (Hadfield et al. 2000).

840 The propensity for Northern Spotted Owls to utilize old structurally complex forests in the California
841 Klamath Province for nesting and roosting is supported by numerous studies on public and private
842 timberlands. Table 3 provides a detailed summary of habitat studies in the Klamath Province. Foraging
843 habitat may contain the typical older forest components of nesting and roosting habitat, but may also
844 include younger forests, hardwood stands, and more open areas (Solis and Gutiérrez 1990, Zabel et al.
845 1995, Irwin et al. 2012, Irwin et al. 2013).

846

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847 **Table 3.** Description of suitable habitat from studies of Northern Spotted Owl habitat relationships in the Klamath
848 Province (partially adapted from USFWS 2009, Table III.C.1).

Study	Location	Method	Description of Selected or Suitable Habitat
USFWS 1992, Bart 1995	Washington, Oregon, northern California	research synthesis (various methods)	conifer-dominated forest with a multi-layered canopy, average DBH1 >30 inches, >60% canopy cover, decadence (snags, logs, deformed trees)
Anthony and Wagner 1999	southwestern Oregon	aerial photographs, ground reconnaissance	conifer-dominated forest with a multi layered canopy, >40% canopy cover, decadence, large snags and logs; characterized by trees >30 inches DBH and >200 yrs
Blakesley et al. 1992	northwestern California	ground sampling, USFS timber stratum maps	coniferous forest characterized by trees >53.3 cm in diameter, forests at 300-900 m elevations for roosting, and the lower third of slopes within a specific drainage
Carey et al. 1992	southwestern Oregon	aerial photographs, forest inventory data, ground reconnaissance	multi-layered canopy, average DBH of dominant trees >39.4 inches, large snags and logs
Dugger et al. 2005	southwestern Oregon	aerial photographs, ground reconnaissance	conifer or mixed forest, >100 yrs; characterized by trees >13.8 inches DBH
Franklin et al. 2000	northwestern California	satellite imagery	forest comprised of >40% conifers, conifer QMD2 >21 inches, hardwood QMD >6 inches, canopy cover >70%
Gutiérrez et al. 1998	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Hunter et al. 1995	northwestern California	satellite imagery	>30% canopy cover, >50% of conifer basal area comprised of trees >21 inches DBH
Irwin et al. 2012	southwestern Oregon and northcentral California	ground sampling, modeling	Selection tied to increasing average diameter of coniferous trees and also with increasing basal area of Douglas-fir trees, increased with increasing basal areas of sugar pine hardwood trees and with increasing density of understory shrubs. Large-diameter trees (>66 cm) appeared important <400 m from nest sites.
Irwin et al. 2013	southwestern Oregon and northcentral California	forest inventory from private and federal landowners, modeling	Basal area (m ² /ha) between 35-60 in nesting period, and 30-54 in winter period, basal area of trees >66 cm was between 7-22 in nesting period, and 7-18 in winter period, QMD 37-60 in nesting period and 37-61 in winter period.
LaHaye and Gutiérrez1999	northwestern California	ground sampling	83% of nests located in Douglas-fir, 60% of nests located in brokentop trees, nest within forests characterized by large (> 90 cm dbh) conifers, a hardwood understory, and a variety of tree

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			sizes.
Meyer et al. 1998	western Oregon	aerial photographs	conifer-dominated forest, trees >80 yrs and/or multi-layered canopy
Ripple et al. 1997	southwestern Oregon	aerial photographs	conifer-dominated forest, average DBH >19.7 inches, canopy cover >60%
Solis and Gutiérrez 1990	northwestern California	timber type classification	average DBH >20.7 inches
Zabel et al. 1993	northwestern California	topographic maps, aerial photographs, and orthophotoquads	stands dominated (in terms of basal area) by trees >20.9 inches DBH; >20% canopy cover of dominant trees and >70% canopy cover of trees >5.1 inches DBH
Zabel et al. 2003	northwestern California	modified timber type classification, varied geographically	<u>nesting-roosting habitat</u> : for most locations average DBH >17 inches and average conifer canopy cover >60%; <u>foraging habitat</u> : in all locations average DBH >9.8 inches and average conifer canopy cover >40%, additional criteria in some locations

849

850 California Cascade Province

851 A description of the California Cascades province is noted below, as defined in the 1992 Northern
852 Spotted Owl recovery plan (USFWS 1992):

853 “The California Cascades province is bordered by the Oregon Cascades province, the Oregon and
854 California Klamath provinces, and the north end of the Sierra Nevada. It is the link between the
855 range of the northern Spotted Owl and the range of the California Spotted Owl. Suitable owl
856 habitat, which is fragmented on a broad scale by high- and low-elevation areas containing
857 marginal habitat, is predominately in two national forests. However, there are significant blocks
858 and checkerboard ownership areas where industrial private lands can provide suitable habitat.”

859 One modeling region described in Appendix C of the 2011 Revised Recovery Plan (USFWS 2011a) makes
860 up the majority of the California Cascades province, Eastern Cascade - South (ECS). The ICC modeling
861 region, which is described above, represents a relatively small southern portion of the California
862 Cascades province. The ECS is described below:

863 “Topography is gentler and less dissected than the glaciated northern section of the eastern
864 Cascades. A large expanse of recent volcanic soils (pumice region: Franklin and Dyrness [1973]),
865 large areas of lodgepole pine, and increasing presence of red fir and white fir (and decreasing
866 grand fir) along a south-trending gradient further supported separation of this region from the
867 northern portion of the eastern Cascades. This region is characterized by a continental climate
868 (cold, snowy winters and dry summers) and a high-frequency/low-mixed severity fire regime.
869 Ponderosa pine is a dominant forest type at mid-to lower elevations, with a narrow band of

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870 Douglas fir and white fir at middle elevations providing the majority of Spotted Owl habitat.
871 Dwarf mistletoe provides an important component of nesting habitat, enabling Spotted Owls to
872 nest within stands of relatively younger, smaller trees.” (USFWS 2011a, pg C-11, C-12)

873 Compared to other provinces in California, very little is known about the specific needs of the Northern
874 Spotted Owl in the California Cascades. In addition, no studies have been conducted to date evaluating
875 habitat quality (the amount and type of habitat most beneficial to owls) across owl sites in the California
876 Cascade Province. Recent telemetry work on foraging habitat use and selection has been conducted on
877 three large study areas at the interface of the southern Cascades and eastern Klamath Mountains in
878 southern Oregon and north-central California (Irwin et al. 2012, 2013). These studies provide valuable
879 information on foraging habitat use in the California Cascade region, but without demographic
880 performance information the results have limited utility for identifying the habitat’s quality for owls.

881 Irwin et al. (2012 and 2013) found that Northern Spotted Owls in Oregon and northwestern California
882 selected areas with greater density and basal area of trees >66 cm dbh (>26 dbh) within 400 m (0.25 mi)
883 of nest sites. The authors suggest a plausible optimal landscape for Spotted Owls in the region might
884 include stands of large-diameter trees near nest sites which are embedded in a heterogeneous forest
885 landscape of various selected foraging types. Modeling owl habitat based upon characteristics used
886 during nighttime foraging excursions, Irwin et al. (2012) found that owls selected mixed-aged and mixed
887 coniferous forest stands. In this study, the Yreka study site was inclusive of dry forest types on the
888 California Cascade Province.

889 In a modeling effort within the Klamath and Cascade provinces, habitat parameters were compared
890 among all forest types within the owls range in California, Oregon and Washington (considered habitat
891 across the entire range at the time) with that of California-specific knowledge of owl habitat within
892 Klamath and Cascade provinces (Zabel et al. 2003). These revised parameters considered new nesting,
893 roosting and foraging habitat types and attributes (e.g., younger trees, elevation, aspect, California-
894 specific soil classes) that the range-wide habitat map left out. The revised model performed better at
895 predicting owl occupancy in California’s interior forest types than the range-wide model. The study
896 concluded that modeling California habitat independent of range-wide habitat was more effective at
897 predicting owl occupancy and numbers in California interior forest types.

898 *Habitat Effects on Survival and Reproduction*

899 Habitat quality has been evaluated in a number of ways including: assessing density of owls in different
900 habitat types, comparing vital rates between owl sites with different habitat conditions, modeling vital
901 rates for populations of owls across broad areas that exhibit differences in landscape scale forest
902 composition, and modeling vital rates at individual owl territories with specific forest structure and
903 composition. The type, extent, and spatial configuration of forests in a high quality territory vary across
904 the range of the Northern Spotted Owl and across regions of California. Although many different
905 combinations of habitat can support a productive Northern Spotted Owl pair with high fitness, the body
906 of evidence suggests minimum thresholds for amounts and distributions of various forest types within
907 any given Northern Spotted Owl home range.

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908 In the recent broad demographic analysis (Forsman et al. 2011), habitat variables were evaluated for
909 effect on fecundity, survival, and rate of population change. Habitat data were not available for
910 California, and so effect of habitat on demographic rates could only be evaluated for Oregon and
911 Washington. In all Oregon study areas, modeling revealed strong evidence for an effect of suitable
912 habitat on fecundity. Four of five Oregon study areas showed declines in fecundity with decreases in
913 suitable habitat, however, the Klamath study area of southwest Oregon showed the opposite
914 relationship, with fecundity declining with increases in suitable habitat. The latter result is consistent
915 with one territory-based analyses in the Klamath province in California which showed an increase in
916 fecundity with decreases in mature forest (Franklin et al. 2000), but is inconsistent with a territory-based
917 analysis in the Klamath province of southern Oregon (Dugger et al. 2005). An additional study in
918 southern Oregon, although not in the Klamath Province, also showed an increase in fecundity with
919 decreases in mature forest (Olson et al. 2004).

920 There was weak evidence for a relationship between the percent cover of suitable habitat and apparent
921 survival for four study areas in Oregon and Washington (Forsman et al. 2011). This is in contrast to three
922 territory-based analyses in California and southern Oregon which found positive relationships between
923 survival and mature forest (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). It is likely that
924 habitat influences demographic rates of individual spotted owls on a home range or territory scale.
925 Therefore where finer-scale data have been available, studies conducted at the scale of owl territories
926 are more likely to detect an effect and are likely more representative of individual Spotted Owl habitat
927 requirements than the broad meta-analysis.

928 Territory-based studies have revealed that owls occupy sites that vary in quality, with pairs exhibiting
929 various levels of survival and productivity in association with habitat type. For example, Bart and
930 Forsman (1992) found that Northern Spotted Owl productivity increased with increasing amount of
931 older forests. Similarly, using turnover rates to define survival Bart and Ernst (1992) found that adults
932 remained in a territory longer when mature and old-growth was present within the territory.

933 Certain habitat characteristics have been shown to support high quality Northern Spotted Owl
934 territories, with both the amount and spatial configuration of different habitat types at a territory
935 contributing to levels of survival and productivity in the resident owls. This measure of habitat quality at
936 the scale of Northern Spotted Owl home range has been termed "habitat fitness potential" (HFP). HFP
937 was defined by Franklin et al. (2000) as "...the fitness conferred on an individual occupying a territory of
938 certain habitat characteristics." and is determined by modeled values of lambda (λ ; defined as annual
939 rate of population change²) and the rates of survival and reproduction that influence λ (Franklin et al.
940 2000, Olson et al. 2004, Dugger et al. 2005). The habitat characteristics that influence HFP include the
941 amount of nesting, roosting, and foraging habitat, as well as the amount of non-habitat. The spatial
942 configuration of these different habitat types around an activity center has also been shown to be

² See section on Demographic Rates below for a discussion of lambda and fitness.

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important in determining HFP. Studies that have evaluated HFP vary somewhat in the size of core areas evaluated and some have evaluated a broader area representing the broader home range. Studies have occurred in southwestern Oregon and northwestern California and so represent different geographic areas and forest types, although most are largely in the Klamath Province of Oregon and California. Three territory-based studies at study areas in the interior of California and southern Oregon have found fairly strong associations between habitat characteristics and demographic rates of northern spotted owls (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). These studies are summarized below and in Table 4.

Each of the three studies attempted to evaluate the effect that older forests (representing nesting/roosting habitat) and other habitat components have on owl demographic rates. In all cases the authors have attempted to capture habitat composed of the oldest forests in the study area to represent high quality nesting and roosting habitat, based on the strong association of the Northern Spotted Owl with mature and old-growth forests. Availability of data for each study area resulted in different definitions of nesting and roosting habitat in each study. Depending on the study, additional attributes evaluated included nonhabitat (e.g., nonforested areas) and amount of edge between various land cover types.

Franklin et al. (2000) modeled the relationship between owl habitat covariates in the core area of Spotted Owl home ranges and Northern Spotted Owl fitness in portions of the north Coast Range and the Klamath Mountains in California. In this study, Northern Spotted Owl habitat was defined as “mature and old-growth forest with a quadratic mean diameter of ≥ 53 cm, quadratic mean diameter of hardwoods ≥ 15 cm, percentage of conifers $\geq 40\%$, and overstory canopy coverage of $\geq 70\%$.” Apparent survival increased with an increased amount of owl habitat, with the amount of edge between owl habitat and other habitat, and at intermediate distances between patches and owl habitat. There was a rapid decrease in survival when the amount of owl habitat fell below about 100 acres (40 hectares) of owl habitat within the core use area. Reproductive rate also increased with an increase of edge between owl habitat and other habitat types, but decreased with increasing amount of owl habitat. Reproductive output had a non-linear relationship with amount of owl habitat, only increasing substantially when the amount of owl habitat was less than 75 to 100 acres (30 to 40 hectares). Variation in survival was attributed mostly to habitat, whereas variation in reproductive output was attributed to both to habitat and climatic events (e.g., cold heavy rains during peak breeding season). HFP was maximized in sites with sufficient owl habitat to facilitate high survival and sufficient edge to facilitate both high survival and high reproductive output. Given this, the authors suggest that there is a trade-off between the amount of owl habitat and edge required to maximize survival and reproduction, while at the same time noting that the components of quality edge habitat are still poorly understood since the study did not discriminate between types or amount of “other habitat”. Despite the trade-off between survival and reproduction, estimates of λ have been shown to be driven by survival rates in Northern Spotted Owls (Forsman et al. 2011), and “...low amounts of spotted owl habitat within a territory will not supply the high degree of edge predicted to support high reproductive output” (Franklin et al. 2000).

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982 **Table 4.** Comparison of three territory-based demographic studies in the interior of California and southern
983 Oregon.

	Franklin et al. 2000	Olson et al. 2004	Dugger et al. 2005
Definition of older forest evaluated in the study (representing nesting/roosting habitat)	Spotted owl habitat = mature and old-growth forest with QMD of conifers >53 cm (~21 in), QMD of hardwoods >15 cm (~6 in), percentage of conifers >40%, and overstory canopy coverage >70%	<u>Late-seral forest</u> = stands characterized by trees with >80 cm (~31.5 in) dbh; generally associated with high quality nesting, roosting, and foraging habitat. <u>Mid-seral forest</u> = stands characterized by trees with 24-80 cm (9.5 - 31.5 in) dbh.	<u>Old forest</u> = older (>100 years) conifer or mixed stands characterized by canopy cover >40% and trees >35cm (~14 in) dbh. <u>Old growth</u> = old (>200 years) conifer-dominated stands characterized by canopy cover >40% and trees >75 cm (~29.5 in) dbh.
Relationship between older forest and <u>survival</u>	Positive Survival declined rapidly at sites with less than ~100 acres of spotted owl habitat in the core area (i.e. <25%) Core area = 390 acres	Positive In general, late-seral forest had a positive effect on survival. However, the best model showed highest survival when combined mid- and late-seral forest was about 70% of the 1,747 acre (1,500-m radius) circle	Positive Pseudothreshold relationship with survival rate dropping rapidly when proportion of old forest in the core drops below ~20-30% (~80-100 acres) Core area = ~413 acres
Relationship between older forest and <u>productivity</u>	Negative Nonlinear relationship with reproductive output increasing when amount of older forest in the core area is less than ~75-100 acres	Negative Productivity declined with increases in mid- and late-seral forest	Positive Linear effect with old growth forest in the core area providing the best model
Amount of older forest in the core area for high fitness territories^a	Variable, with an apparent trade-off between providing sufficient older forest to support survival and provide a high amount of edge, while limiting portion of core area in older forest in order to support high productivity (see Fig 10 in Franklin et al.; generally at least ~25% older forest required in core to support high fitness)	N/A The best model included only the 1,500m diameter circle (~1,747 acres representing broader home range)	In general, territories with <40% of the 413 acre core (~165 acres) composed of older forests had habitat fitness potential <1.0
Effect of habitat in broader home range or 'outer ring' on vital rates^b	N/A	Territories with high estimates for λ had a high amount of mid- and late-seral forest in the 1,747 acre area, but also have patches of nonforest within the mosaic of forest types	Survival declined when the amount of nonhabitat in the outer ring portion of the home range exceeded about 60%.
Relationship of vital rates with the amount of non-habitat (non-forest areas, sapling stands, etc.)	Did not evaluate ^c	Increases in early seral and nonforest had a negative effect on survival	Survival decreased dramatically when the amount of non-habitat exceeded ~50% of the home range

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Relationship of vital rates with amount of edge between older forest and other vegetation types^d	Both apparent survival and reproductive output increased with increasing edge between spotted owl habitat and other vegetation types ^e	The best model showed a positive relationship between productivity and amount of edge between mid- and late-seral forest and the other types (early-seral and nonforest).	No support for either a positive or negative effect on survival or reproductive rate
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^aSize of the core area evaluated varies across studies. Franklin et al. (2000) evaluated a 390 acre core area. Olson et al. (2004) evaluated a ~279 acre core area, but their best model included only the 1,500m diameter circle (~1,747 acres). Dugger et al. (2005) evaluated a ~413 acre core area.

^bSize of the broader home range or 'outer ring' evaluated varies across studies. Franklin et al. (2000) did not include an outer ring of habitat or broader home range in their modeling. Dugger et al. (2005) evaluated a ~3,455 acre outer ring. In addition to the core area, Olson et al. (2004) evaluated two larger circles of habitat of ~1,747 and ~4,473 acres.

^cFranklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types.

^dEdge is defined differently among the studies. Franklin et al. (2000) defined edge as occurring between mature forest (spotted owl habitat) and all other vegetation types. Olson et al. (2004) and Dugger et al. (2005) define edge as occurring between nonhabitat and all intermediate and mature forest types.

^eFranklin et al. (2000) were unable to distinguish different types of edge, but suggested that edges between spotted owl habitat and clearcuts do not generate the type of mosaic that was observed in high-fitness territories.

In their Oregon coast study area, Olson et al. (2004) analyzed various forest types: late-seral, mid-seral (broken further into conifer and broadleaf), and non-forest, within 600, 1,500 and 2,400 m radius around Northern Spotted Owl site centers. The best model indicated survival was highest when the amount of mid- and late-seral forest was about 70% within the 1,500 m (0.9 mi) radius circle, and survival decreased when the amount of mid- and late-seral forest increased above about 85% or declined below about 50%. Increases in early seral or non-forest had a negative effect on survival. The best model indicated reproductive rates were positively correlated to the amount of edge between mid-seral and late-seral forest and other forest types (early-seral or non-forest), and suggested a high amount of mid- and late-seral forest in the 1,747 acre area with patches of nonforest within the mosaic of forest types provided high fitness.

In an Oregon study (including portions of the western Cascades and eastern Siskiyou Mountains, both comparable to areas in California), Dugger et al. (2005) found the best models contained a positive linear effect of older forest types in the core area (defined as 413 acres) on reproductive rate, with the best model including old-growth. There was strong evidence to support a positive relationship between amount of older forest types in the core area, and an increase in apparent survival. Dugger et al. (2005) found little to no effect on survival and reproduction rate for intermediate-aged forests, defined as forests between sapling and mature stages with total canopy cover over 40%. The study also analyzed habitat within a broader area around the core area, representing an outer ring of the home range (3,455 acres outside of the core area). Within the broader area, survival declined when the amount of non-habitat, defined as non-forest and early seral stages including sapling stage, within the ring outside the core area exceeded 60%. Survival estimates were highest when the amount of non-habitat fell between roughly 20 to 60% in the broader portion of the home range, and survival estimates were lower as non-habitat fell below 20% or above 60%. Modeling efforts did not find any direct effect of edge, although edge was defined differently than in the Franklin et al. (2000) study. Although Dugger et al. (2005) did

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not find any evidence that a mosaic of old forest intermixed with forests of intermediate age (with hardwood component) provided benefit to the Northern Spotted Owl, nor a benefit of edge, the negative quadratic relationship between owl survival and amount of non-habitat in the broader portion of the home range may suggest some benefit of an intermediate amount of “edge” in this larger area. The study concludes, “in general, territories with <40% old forest or old-growth habitat near the site center had habitat fitness potential <1, consistent with the relationships between both reproduction and survival and the amount of old forest habitat at the core.”

All three of the above studies found a positive relationship between the amount of late-seral forest and survival, with two (Franklin et al. 2000, Dugger et al. 2005) showing a rapid decline in survival when the amount of late-seral forest in the core area dropped below about 25% (i.e., about 100 acres of late-seral forest is required in the 400 acre core to support survival). The third study (Olson et al. 2004) found that declines in survival accelerated when the amount of mid- and late-seral forest in a larger area (~1,750 acre) declined below 50%, with highest survival at 70% mid- and late-seral forest. Two of the three studies found a negative relationship between the amount of older forest and productivity in the core area (Franklin et al. 2000) or in the broader home range (Olson et al. 2004); this shows an apparent trade-off between providing sufficient older forest to support survival, while limiting the amount of older forest in order to support high productivity. The third study found a positive relationship between older forest in the core area and productivity (Dugger et al. 2005).

Dugger et al. (2005) found that territories required that about 40% of the core area be composed of older forests in order for HFP to be greater than 1.0. The results of Franklin et al. (2000) suggest that about 25% of the core area must be in older forest to support high fitness. The two studies that evaluated a broader home range found that the amount of non-forested area and other forms of nonhabitat must be limited in order to support high HFP (Olson et al. 2004, Dugger et al. 2005). Olson et al. (2004) and Dugger et al. (2005) both found that survival decreased dramatically when the amount of early seral forest or other non-habitat exceeded ~50% of the home range.

In their coastal study area within California’s Humboldt and Del Norte counties, Thome et al. (1999) showed that reproductive rate was inversely related to age class and basal area age classes within forests managed with clear-cut silviculture practices. Specifically, sites with high proportions of 21-40 year-old stands, lower proportions of 61-80 year-old stands and the largest basal area class (>69 m²/ha) had higher reproduction; however sites with higher reproduction also had more residual trees at 50 hectare circle (0.149 trees/ha) and 114 hectare circle (0.201 trees/ha) surrounding owl sites. The explanation was presumed to be related to the larger abundance of preferred prey (i.e., woodrats) among younger forests coupled with the limited availability of older forests on the study area. The authors concluded that 21-40 year-old stands were young enough to contain sufficient amounts of prey during foraging, yet old enough to provide structural for roosting, nesting, and maneuverability, such as high canopy and large residual trees.

It is important to note that the relationships found between owl fitness and habitat in the studies described above apply only to areas with similar conditions as those analyzed as part of the studies, and findings may not be applicable to owl territories throughout the owl’s entire range in California. For

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example, the study area described in Olson et al. (2005) comprised different forest types than those described in Dugger et al. (2005) or Franklin et al. (2000) and where the primary food source was flying squirrels rather than woodrats.

Overall, Northern Spotted Owls require some minimum level of older forest, including old-growth, within their core range area and broader home range to optimize survival and productivity. It is also apparent that older forest mixed with other forest types (excluding non-habitat) benefits Northern Spotted Owl fitness, at least partially due to the increased foraging opportunities along transitional edges. This effect may be more prevalent in the interior zones of California and southern Oregon, (Klamath and Cascade provinces) where owl habitat differs significantly than coastal or more northern portions of the range. In spite of uncertainties around which level of old forest and edge attains the best fitness for owls, the literature points to the benefits of a mosaic of forest types that contain sufficient older forest, especially around the core area, while limiting the amount of nonhabitat in the home range. Based on the studies in the interior of the species' range in California and southern Oregon, management that maximizes late-seral forest in the core area (at least 25-40%) while limiting the amount of nonforest or sapling cover types throughout the home range (no more than about 50%) would likely result in high quality Spotted Owl territories.

Comment [JEH3]: I don't think they require "old-growth" per se.

Comment [JEH4]: Use consistent terms.

Comment [A5]: Note to external reviewers: Prior to final draft, we will consider adding Figure 6 from Dugger et al. (2005) or Figure 10 from Franklin et al. (2000) to illustrate the amounts and configuration of various habitat types in high quality territories.

Status and Trends in California

Abundance

No range-wide estimate for abundance of Northern Spotted Owl exists because survey methods and effort conducted to date do not provide for reliable estimation of population size across the range (USFWS 2011a). Few areas across the range have been sufficiently sampled to accurately estimate densities of Northern Spotted Owls (Franklin et al. 1990, Tanner and Gutiérrez 1995, Diller and Thome 1999). As mentioned above, Northern Spotted Owl densities vary across the range and forest types and so extrapolating the few local estimates across the range of the subspecies would result in biased estimates of abundance (See Life History section of this report for detailed information in density estimates in California). Because Northern Spotted Owls have large home ranges it is necessary to systematically survey very large areas in order to obtain reliable estimates of density (Franklin et al. 1990). Diller and Thome (1999) suggested that unless most individuals in a population are marked, density estimates would be biased. Studies that have provided density estimates have applied only to territorial owls (Diller and Thome 1999). Surveys do not effectively sample nonterritorial individuals (floaters); therefore, little is known about the floater population of owls other than they exist and that they generally do not respond to broadcast surveys. This leads to an issue of detectability that is difficult to overcome in estimating density or abundance of Northern Spotted Owls in a given area. Without an effective sampling method that addresses the ability to detect all owls in a given area, it is not possible to provide an accurate estimate of abundance. See the discussion on occupancy in the Demographic Rates section of this report for potential effects of floater owls on occupancy rates at known owl sites.

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An early report out of the California Forestry Association (Taylor 1993) attempted to derive a population estimate for the Klamath Province in California. However, many assumptions were required in the analysis process, especially in developing estimates for amount of suitable habitat on federal and private land, estimating the fraction of land that had previously been surveyed, and estimating the proportion of sites that are occupied. In addition, no criteria were mentioned for what constituted “suitable” habitat, although 100% of forested land not owned by the USFS was considered to be suitable. The paper acknowledges that several of the assumptions made in deriving the population estimate are untested and that high levels of uncertainty exist in many of the estimates. Taylor (1993) partitioned land into ownership type, estimated the amount of suitable habitat on each type, estimated the fraction of land surveyed on each type, used the number of activity centers in the Department database and the estimates for fraction of suitable habitat surveyed to obtain an estimate of total sites in each type, and used an average occupancy rate from a subset of sites to extrapolate occupancy across the entire province. Estimates for suitable habitat and the percentages of suitable land surveyed for owls were derived from telephone interviews with landowners, timber company GIS layers and Timber Harvest Plan (THP) data, and a U.S. Forest Service report for National Forests. Due to the many untested assumptions and high amount of uncertainty in estimates, and the vague description of methods used, the report cannot be considered to provide a valid population estimate for the Klamath Province.

A recent study made use of the immense amount of data available on Northern Spotted Owl habitat requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity, dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the range of the owl (Schumaker et al. 2014). In addition to an evaluation of source-sink dynamics, outcomes of the model included a range-wide population size estimate, and the proportion of the population in each modeling region and physiographic province noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). Estimates of regional population sizes indicate that Northern Spotted Owls are most abundant in parts of southern Oregon and northern California (Table 5). The three California provinces were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population. The model indicated that the Klamath region is a stronghold for the population, with 50.1 percent cumulatively within the Oregon Klamath and California Klamath provinces, and 37.1 percent within the Klamath East and Klamath West modeling regions. Schumaker et al. (2014) estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions. Although informed by the best available data to develop an impressive assessment of source-sink dynamics across the range, the complexity of the model may limit its ability to accurately model population estimates. For example, differences in the simulated number of owls versus the numbers observed in eight demographic study areas used for calibration ranged from 5 to 47 percent (Schumaker et al. 2014). Nevertheless, the results suggest that California’s population of Northern Spotted Owls is an important component of the range-wide population.

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Table 5. Percent of range-wide Northern Spotted Owl population within modeling region and physiographic province (adapted from Table 2 in Schumaker et al. 2014).

Modeling Region	Percent of Population	Physiographic Province	Percent of Population
North Coast Olympics	0.1	Washington Western Cascades	1.3
West Cascades North	0.1	Washington Eastern Cascades	1.6
East Cascades North	3.3	Washington Olympic Peninsula	>0.0
West Cascades Central	1.2	Washington Western Lowland	>0.0
Oregon Coast	1.0	Oregon Eastern Cascades	3.5
West Cascades South	15.3	Oregon Western Cascades	23.3
Klamath West	20.0	Oregon Coast	0.8
Klamath East	17.1	Oregon Willamette Valley	>0.0
Redwood Coast	16.4	Oregon Klamath	13.7
East Cascade South	3.8	California Coast	16.6
Inner California Coast	21.7	California Cascades	2.8
		California Klamath	36.4

Most surveys for Northern Spotted Owls have been conducted on areas proposed for timber management activities in order to assess the potential for impacting the species, or on demographic study areas throughout the subspecies range. Although not designed for estimating density or abundance, pre-harvest surveys have dramatically increased knowledge on location of territorial owl sites (i.e., activity centers). As survey effort has expanded to new areas over time, the number of known activity centers has naturally increased. Although owls will shift activity centers over time, they exhibit high site fidelity to general nesting and roosting areas (Gutiérrez et al. 1995, Blakesley et al. 2006), therefore the increase in number of activity centers over time is more likely a result of expanded survey effort than establishment of new activity centers. In addition, across most of the Northern Spotted Owl range establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a slow process given tree species growth rate, and so a rapid increase in the number of activity centers due to colonization of new habitat is unlikely. The possible exception to this is on the redwood coast where Northern Spotted Owls have been shown to select relatively young forests (41-60 years old) for nesting and roosting, as long as all habitat requirements are present (Thome et al. 1999). For example, Green Diamond Resource Company has reported the addition of 58 new sites since 1994 in a portion of their property that is completely surveyed each year and attributes this at least in part to improving habitat conditions as forests mature (GDRC 2015). However, the annual number of known Northern Spotted Owl sites on GDRC lands ranged from 99 to 186 from 1991 through 2014 (mean 134.5), with 122 sites known in 2014 (GDRC 2015). The number of newly established activity centers across the range as a result of newly available nesting and roosting habitat is unknown. See the discussion on habitat changes in the threats section for additional information on the topic of habitat recruitment. The Humboldt Redwood Company reported that there 136 known activity centers in 2014, and:

“The total number of HCP lands activity sites has remained relatively constant over the HCP years (range 149-215, mean 187). Only 149 activity sites were reported in the first year of HCP implementation (1999) when not all of the lands were surveyed.”

Comment [JEH6]: You may want to reword or reconsider this in light of my edits below.

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has also reported an increase in number of sites since 2008 (HRC 2015). A concurrent increase in detections of Barred Owls in heavily surveyed areas suggests that the increase in Spotted Owl activity centers is likely due at least in part to increased survey effort (see Figure 28 in the Threats section of this report). However, it is possible that the increase in Spotted Owl activity centers is due to the movement of Spotted Owls as a result of displacement by an increasing number of Barred Owls (HRC 2015) or displacement from lands that are no longer suitable due to timber harvest or wildfire. In some situations increases in numbers of activity centers over time is simply due to the fact that the numbers are cumulative, and include unoccupied activity centers.

Comment [JEH7]: I don't understand this sentence. Increased barred owls moving NSO around and increased survey effort are 2 different explanations (although not mutually exclusive) for why numbers of ACs may go up over time in some areas.

In California, the number of known Northern Spotted Owl activity centers rapidly increased starting around 1990 when listing under the federal Endangered Species Act resulted in a widespread increase in survey effort (Figure 3). Through 1989, there were 1,366 known Northern Spotted Owl activity centers in California. By the year 1999, this number had increased to 2,799. As of 2014, the number of known Northern Spotted Owl activity centers was 3,116. The number of occupied activity centers in any given year is unknown because not all areas have been or can be surveyed on an annual basis (USFWS 2011a). It is likely that many Some unknown portion of the known sites are actually unoccupied in any given year because of habitat loss due to timber harvest or severe fires, displacement by Barred Owls, normal death of owls or their movement out of established territories, or other factors, therefore much of the data from early survey reports are outdated and of little use in addressing population abundance or distribution questions (Courtney et al. 2004). For these reasons and for the sampling reasons discussed above, the number of activity centers does not represent an index of abundance but rather the cumulative number of territories recorded (USFWS 2011a).

Demographic Rates

“Because the existing survey coverage and effort are insufficient to produce reliable range-wide estimates of population size, demographic data are used to evaluate trends in Spotted Owl populations” – USFWS (2011a).

The U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) initiated eight long-term demography studies within the range of the Northern Spotted Owl during the years 1985 to 1991 in order to provide data on the status and trends of Spotted Owl populations, and to inform the effectiveness of the NWFP on federal lands (Lint et al. 1999). Three additional demographic study areas that were not established under the NWFP have also been initiated. The additional study areas that are currently active include one entirely on private land (i.e., Green Diamond Resource Company), one on the Hoopa Indian Reservation land, and one composed of a mix of federal, private, and state lands (i.e., Rainer). The study areas range between Washington and northern California, and collectively represent about 9% of the range of the Northern Spotted Owl (Forsman et al. 2011; Figure 7).

These eleven study areas have been monitored annually since inception with an average of 19 survey years across all areas (Table 6). On each study area, territorial owls are captured and banded, followed by annual attempts to recapture or resight owls and to evaluate reproductive success of territorial pairs. Standard protocols ensure consistent and thorough attempts to band and resight territorial owls and to

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assess nesting status of territorial females (Anthony et al. 2006). Over the period of 17-24 years (depending on study area), a total of 5,224 non-juvenile owls have been marked in the eleven study areas with a total of 24,408 annual captures/recaptures/resightings, allowing for robust estimates of survival. The number of young produced by territorial females was determined in 11,450 separate cases (Forsman et al. 2011). Three study areas are located in California, representing a diverse land ownership; the Northwest California study area (NWC) is primarily on federal land, the Green Diamond Resource Company study area (GDR) is on private land, and the Hoopa Indian Reservation study area (HUP) is on tribal land. These three study areas cover approximately 6% of the range of the Northern Spotted Owl in California (based on the USFWS range). The GDR study area is entirely within the California Coast Province, the HUP study area is located on the western edge of the California Klamath Province, and the NWC study area is mostly in the Klamath Province with a small portion in the Coast Province. There is no demographic study area in the California Cascades Province.

Table 6. Descriptions of 11 demographic study areas used to assess vital rates and population trends through 2008. Adapted from Table 1 and Appendix A in Forsman et al. (2011).

Study Area	Acronym	Years	Area (km ²)	Ownership
<i>Washington</i>				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
<i>Oregon</i>				
Coast Ranges*	COA	1990-2008	3,922	Mixed
H.J. Andrews*	HJA	1988-2008	1,604	Federal
Tye*	TYE	1990-2008	1,026	Mixed
Klamath*	KLA	1990-2008	1,422	Mixed
South Cascades*	CAS	1991-2008	3,377	Federal
<i>California</i>				
NW California*	NWC	1985-2008	460	Federal
Hoopa Tribe	HUP	1992-2008	356	Tribal
Green Diamond	GDR	1990-2008	1,465	Private

*Indicates the eight study areas that are part of the federal monitoring program for the northern spotted owl.

Data from the demographic study areas have been compiled and analyzed regularly, with the most recent analysis covering all survey years through 2008 (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011). Demographic rates are estimated for each study area, and for all study areas combined (meta-analysis). An additional meta-analysis of data from the demographic study areas is ongoing and will include data through 2013. This additional information should provide further insight into important demographic rates across the species range. As discussed above, data collected from existing surveys are not sufficient to estimate population sizes, and so population trends cannot be assessed by comparing estimates of population size over time. However, the consistent collection of large amounts of capture/recapture data and observations of reproductive effort has resulted in an enormous amount of information which allows for estimation of vital rates across much of the range of the Northern Spotted Owl. When sufficient data is available,

Comment [A8]: Note to external reviewers: Where more recent data on demographic rates are available, either through annual reports or through presentations that have been publicly available, we include results as appropriate. We will update this report to include full results of the ongoing meta-analysis if the full publication becomes available prior to finalizing this status review.

Comment [JEH9]: Yes, a good idea wait for the results from the upcoming meta-analysis.

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examination of demographic trends in survival and reproduction is one of the most reliable methods of assessing the health of a population. These data also allow for estimation of the annual rate of population change, λ , which reflects changes in population size resulting from reproduction, mortality, and movement into and out of a study area. λ does not provide a numerical estimate of population size, but instead estimates the proportional change in a population over a set period of time.

In addition to the coordinated analysis of data from all demographic study areas that occurs every 5 years, reports are available from individual study areas. Results from these reports are included in the discussion below when they offer more current information on the three California study areas than the most recent coordinated meta-analysis of 2011.

Rate of Population Change

A primary goal of the large scale monitoring at the demographic study areas and the regular coordinated analysis of data is to monitor population trends of the Northern Spotted Owl through estimation of λ (λ , defined as annual finite rate of population change) (Anthony et al. 2006, Forsman et al. 2011). A λ of 1.0 indicates that a population is stationary, whereas values greater or less than 1.0 indicate increasing or declining populations, respectively. The most recent meta-analysis for all eleven study areas produced a weighted mean λ of 0.971 (standard error = 0.007, 95% confidence interval = 0.960 to 0.983), corresponding to an average rate of population decline of 2.9% per year from 1985 to 2006 (Forsman et al. 2011). Estimates of λ were below 1.0 for all 11 individual study areas, and ranged from 0.929 to 0.996 (Table 7). Population declines were most pronounced in Washington and the Coast Ranges of Oregon. The 95% confidence intervals do not overlap 1.0 for seven of the study areas, indicating strong evidence for population decline on these seven study areas. Although this study area-level demographic analysis did not show evidence for declines at KLA and CAS study areas, a territory-based study conducted in the Klamath Mountains and Cascade Range of southwest Oregon showed evidence for declining populations by 1996 (Dugger et al. 2005). In California, populations at GDR and NWC have declined, with estimates of λ of 0.972 for GDR (2.8% decline per year) and 0.983 for NWC (1.7% decline per year).

In a more recent analysis of the available data, Franklin et al. (2015) reported a λ of 0.976 (1985-2013; 95% CI 0.953-0.998) for the Willow Creek Study Area (part of the NWC study area). This shows an accelerated rate of decline (2.4% decline per year) compared to that reported by Forsman et al. (2011) for NWC. As reported in Forsman et al. (2011), the 95% confidence interval for HUP overlapped 1.0, so the study could not conclude that this population was declining through 2008. However, Higley and Mendia (2013) reported a λ of 0.977 (1985-2012; SE = 0.01; 95% CI 0.958-0.996) equating to a 2.3% population decline per year through 2012. This is the first time that the 95% CI for HUP does not include 1.0, providing strong evidence that all three study areas in California now have declining populations of owls.

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Table 7. Demographic parameters for the Northern Spotted Owl demographic study areas through the year 2008. Adapted from Table 22 in Forsman et al. (2011) and Table A-1 in USFWS (2011).

Study Area	Fecundity	Apparent Survival ¹	Lambda (λ)	Population Change ²
<i>Washington</i>				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
<i>Oregon</i>				
Coast Ranges	Increasing	Declining	0.966	Declining
H.J. Andrews	Increasing	Declining	0.977	Declining
Tyee	Stable	Declining	0.996	Stationary
Klamath	Declining	Stable	0.990	Stationary
South Cascades	Declining	Declining	0.982	Stationary
<i>California</i>				
NW California	Declining	Declining	0.983	Declining
Hoopa	Stable	Declining	0.989	Stationary
Green Diamond	Declining	Declining	0.972	Declining

¹ Apparent survival calculations are based on model average.

² Population trends are based on estimates of realized population change.

Conversion of estimates for λ to estimates of realized population change (i.e., the proportional change in estimated population size relative to population size in the initial year of analysis) revealed dramatic declines in regional population sizes (Forsman et al. 2011). The study areas in the northern portion of the range showed precipitous declines, with populations in the Olympic, Cle Elum, and Rainier study areas in Washington and the Coast Range study area in Oregon estimated to have declined by 40 to 60% during the study period (Forsman et al. 2011). At a rate of decline of 2.9% per year, the total population of Northern Spotted Owls across all study areas would have declined by nearly 50% over the 22 years included in the study. Although the 95% confidence intervals for estimates of realized population change slightly overlapped zero, two study areas in California (NWC and GDR) showed estimated population declines of about 20% during the period of study. Using the revised estimate of λ for NWC through year 2013 (Franklin et al. 2015) would result in a larger estimated population decline for NWC. The other study area in California (HUP), showed a slight decline in population size at the end of the study period in 2008, but the 95% confidence interval broadly overlapped zero. Again, using more recent data such as those reported by Higley and Mendia (2013) would provide stronger evidence for a population decline at HUP.

Although the meta-analysis assessing vital rates on all demographic study areas through 2013 is ongoing, preliminary meetings held to coordinate data compilation and analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; the average rate of population decline per year on the eleven demographic study areas has been 3.8% per year (Dugger et al. in review, Higley and Mendia 2013), compared to a decline of 2.9% per year using data

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through 2008 (Forsman et al. 2011). The ongoing analysis has revealed large changes becoming apparent in Oregon and California, with Northern Spotted Owl populations in California declining by 32-55% over the study period (1985-2013; Dugger et al. in review).

Fecundity and Survival

Fecundity (i.e., number of female young produced per adult female) and survival rates are estimated in order to inform estimates of λ , to determine the degree to which changes in these vital rates effect populations, and to model effect of potential explanatory variables on these important vital rates. The Northern Spotted Owl is a long-lived species, with relatively high adult survival rates, and with high variability in fecundity from year to year. Fecundity estimates varied across study areas and ranged from 0.230 to 0.553 female young produced per adult female (Forsman et al. 2011). Most Spotted Owls do not breed every year, but more normally breed every other year, which contributes to low fecundity in the species. There was evidence for declining fecundity on five areas, three areas were stable, and three areas showed increasing fecundity (Forsman et al. 2011). In California, fecundity showed declines on two areas (NWC and GDR) and was stable on one area (HUP), although HUP exhibited the lowest fecundity rate of all eleven study areas. Adult survival has declined on 10 of 11 study areas, with the Klamath study area in Oregon being the exception. Annual survival rate represents the probability that a bird that was alive in one year will be alive the following year, therefore a mean rate of 1.0 would indicate that all birds survive from one year to the next. Values of mean apparent adult survival for the entire study period range from 0.819 to 0.865, with declines most pronounced in Washington and Oregon. Apparent survival rates in Washington had been less than 80 percent in years leading up to 2008, a rate that is unlikely to allow for sustainable populations (Forsman et al. 2011). Although less severe than in Washington and much of Oregon, all California study areas show declines in survival (Table 7).

For most demographic study areas, changes in λ were driven mainly by changes in survival. This is consistent with the hypothetical expectation from a long-lived species with high variability in fecundity over time, and is also consistent with previous studies showing that annual rates of population change are most influenced by changes in adult survival (Noon and Biles 1990, Lande 1991, Blakesley et al. 2001). This is a concerning finding because survival was shown to be declining on 10 of 11 study areas across the entire range of the subspecies, including all three California study areas. In the previous demographic analysis analyzing data from 1985-2003 (Anthony et al. 2006), declines in adult survival in Oregon had not been observed and only one study area in California showed declines, therefore declines in survival in the southern portion of the range occurred predominantly in the most recent five years for which data were available (2004-2008). The overall assessment from the most recent demographic study (Forsman et al. 2011) is that reproduction and recruitment have not been sufficient to balance losses due to mortality and emigration, so many of the populations on study areas have declined over the two decades included in the study.

When the NWFP was implemented, it was assumed that Northern Spotted Owl populations would continue to decline for up to a few decades, but would gradually increase and eventually stabilize as

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habitat protection and successional processes increased available habitat on reserve lands (USDA and USDI 1994). To date, five meta-analyses have been conducted on data from Northern Spotted Owl demographic study areas, with results readily available for three of the analyses. A sixth analysis is ongoing and will include all survey years through 2013. In the second meta-analysis which summarized results through 1993 (Burnham et al. 1996), no trend in fecundity was detected and survival was shown to be declining among adult female owls; λ was less than 1.0 for most study areas. The fourth meta-analysis which covered data through 2003 (Anthony et al. 2006) found evidence for declining fecundity at six study areas (although 95% confidence intervals overlapped zero for all six areas), and strong evidence that survival was declining on four of 14 study areas included in the analysis (two of which no longer participate in the demographic analysis). Mean λ across all study areas was also less than 1.0 with an annual rate of population decline estimated to be 3.7%, although only four study areas had 95% confidence intervals for estimates of λ that did not overlap 1.0 (Anthony et al. 2006). The fifth and most recent meta-analysis covers data through 2008 (Forsman et al. 2011) and provides strong evidence for a decline in fecundity on 5 of 11 study areas and strong evidence for declining survival on 10 of 11 study areas. After two decades of NWFP implementation, it is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of demographic rates indicate that across much of the range, the decline has accelerated. This is evident in the declining populations on seven of the 11 study areas, only two of which showed strong evidence for decline in the previous analysis.

In California, two of three study areas (NWC and GDR) in the recent analysis were shown to be experiencing declines in fecundity and all California study areas showed declines in survival (Forsman et al. 2011). The previous analysis also found evidence of declining fecundity on two California study areas but found evidence for declining survival on only one (Anthony et al. 2006). Although estimates of λ for study areas in California are not as low as those in Washington and northern Oregon, negative trends in vital rates had led to population declines on at least two of three California study areas by 2008 (NWC and GDR). The decline at the NWC study areas had apparently not begun by 1994 (Franklin et al. 2000). Although Northern Spotted Owls at the southern portion of the range appear to have been temporally buffered from population declines, the ongoing and accelerating decline in demographic rates had effected populations in California by 2008.

Most of the demographic study areas were established to evaluate the effectiveness of the NWFP and consist of federal lands or a mix of federal and nonfederal lands. Although not randomly chosen, Forsman et al. (2011) suggests that results from the demographic study areas are representative of federal lands and areas of mixed federal and private lands throughout the range of the Northern Spotted Owl because “the study areas were (1) large, covering about 9% of the range of the subspecies; (2) distributed across a broad geographic region and within most of the geographic provinces occupied by the owl; and (3) the percent cover of owl habitat was similar between our study areas and the surrounding landscapes”. The authors expressed less confidence that study areas reflected trends on non-federal lands because the two study areas consisting mainly of non-federal lands (GDR and HUP) are near the southern edge of the subspecies’ range and both are actively managed for Spotted Owl habitat. These two non-federal study areas might not accurately represent other non-federal lands in California because of the management mentioned above and because they are located in the California

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Coast and western edge of the California Klamath physiographic provinces, and may not accurately represent conditions in other parts of the California range, especially the California Cascades. The authors suggested that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands (Forsman et al. 2011).

Although results from the ongoing meta-analysis for the eleven demographic study areas are not yet available, recent reports from individual study areas in California (NWC, HUP, and GDR) provide information on current estimates for reproductive success and survival. At GDR, reproductive success (number of young fledged per monitored site) showed a negative trend from 1992-2014 (regression slope = -0.014), with a mean of 0.54 during this time period (GDRC 2015). This is a different metric of fecundity than used in the most recent demographic analysis (Forsman et al. 2011; number of female young produced per adult female), but shows a continuing decline in productivity since 2008. On HUP, mean reproductive rate (young fledged per monitored female; also a different measure of fecundity) from 1991-2013 was 0.42 with a range of 0.05 to 1.04 (Higley and Mendia 2013). During 2011, 2012 and 2013 HUP showed unusually low reproductive rates of 0.05, 0.13, and 0.06, respectively. In 2013, adult survival was approximately 0.8 on HUP (Higley and Mendia 2013), which is lower than that reported by Forsman et al. (2011). Annual apparent survival for territories surveyed on NWC averaged 0.848 for 1985-2014 (Franklin et al. 2015). Reproductive rate has also been reported for private timberlands outside of the demographic study areas, although monitoring and analysis approaches are not standardized as in the eleven demographic study areas, so direct comparisons are not possible. Humboldt Redwood Company reported a reproductive rate (number of young per pair) of 0.49 in 2014 (HRC 2015) and Mendocino Redwood Company reported a reproductive rate of approximately 0.12 in 2014 (MRC 2014). HRC (2013) noted a drop in reproductive rate since 2009. These more recent estimates of reproductive rate and survival since the last demographic meta-analysis (Forsman et al. 2011) are consistent with a continued decline within the demographic study areas in California.

As mentioned in the Life History section, most Spotted Owls do not breed every year and annual variation in reproductive effort and success is thought to be related to local weather conditions and fluctuations in prey abundance. This results in most areas having high variation in reproductive success between good years and bad years and can be seen in modeled rates of fecundity (Forsman et al. 2011). In the coastal portion of the Northern Spotted Owl range in California, many areas reported consistently low reproductive success from 2011-2013, including some of the lowest reproductive success rates on record in 2013. This is despite weather conditions in 2013 that would typically support good reproductive success. This was observed on many timber company lands (Calforests 2014, HRC 2014, GDRC 2015), tribal lands (Higley and Mendia 2013), and National Park land (Ellis et al. 2013). The reason for this widespread pattern of low reproductive success is not known.

In addition to providing rigorous estimates of survival, productivity, and population change across much of the range of the Northern Spotted Owl, the large amount of data and the regular demographic analyses allow for investigation of potential associations between population parameters and covariates that might explain estimates and trends (Forsman et al. 2011). Potential explanatory variables included in modeling during the most recent analysis of fecundity, survival, and λ included multiple weather and climate covariates, a habitat covariate, a Barred Owl covariate, and several other broad geographic

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covariates. Unlike studies that have modeled vital rates and potential explanatory variables at the scale of individual owl territories (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005), the meta-analysis evaluates covariates as an average effect across large study areas. The Barred Owl covariate was evaluated as the proportion of Northern Spotted Owl territories in each study area that had Barred Owls detected within a 1-km (0.62 mi) radius of activity centers. The habitat variable was the proportion of “suitable habitat” (based on Davis and Lint (2005), but generally characterized as containing large overstory conifers (dbh > 50cm) and canopy closure >70% in the study area). Although modeling average effect across large study areas is not as powerful at detecting effects that are influential at the territory scale (e.g., presence of Barred Owl or habitat conditions), data limitations required a coarser evaluation at the broad scale of the demographic analysis in order for methods to be consistently applied across study areas (Forsman et al. 2011). The broad demographic analysis found relatively weak associations between the amount of habitat and demographic rates, and somewhat larger effects of Barred Owl. These results, and those from more powerful territory-based studies, are discussed in the Habitat Requirements section and in the Threats section of this report.

Occupancy

Occupancy data are less resource-intensive to collect compared to data required to estimate the demographic parameters discussed above. Estimation of survival and reproduction requires the capturing and banding of owls at known sites, and multiple annual visits to all sites in order to recapture or re-sight owls, and to determine reproductive status. Occupancy data is based on the presence or absence of owls from known sites, and depending on the objectives of the monitoring does not necessarily require the monitoring of all sites each year. Due to this reduced requirement in survey effort and the necessity to visit known owl sites during pre-timber harvest monitoring, this type of data has frequently been collected and reported by timber companies and by other landowners (e.g. National Parks).

Although occupancy might appear to provide a substitute for estimates of survival, reproduction, or the rate of population change, it is not always appropriate to use an apparently stable occupancy rate to suggest a stable population size. As explained by Forsman et al. (1996),

“...it is possible that in a declining population, observed densities of territorial owls might not change during early years of the decline simply because territorial owls that died could be replaced by floaters (owls without territories) (Franklin 1992). Thus, significant changes in density of territorial owls might not become apparent for many years, especially if the rate of population decline was small (e.g., 1-2% per year).”

Therefore, a lack of a significant decline in observed owl numbers cannot necessarily confirm or refute estimates of survival or λ . Although little is known about the floater population of Northern Spotted Owls at any study area, other than that they exist and that they do not readily reply to broadcast calling, the number of floaters is finite. The perception of population stability due to establishment of territories by floaters cannot continue indefinitely in a constantly shrinking population. Depending on the rate of population decline (λ), the phenomenon should gradually disappear as the floater population is

Comment [A10]: Note to external reviewers:
The ongoing demographic analysis covering all survey years through 2013 will include occupancy modeling for the first time. Though we have included some preliminary results in this report when available (cited as “Dugger et al. in review”), we will update prior to finalizing if the full publication becomes available.

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depleted. If a study area has a relatively robust population of floaters, or if emigration into the study area occurs, the local population can decline for some time before being detected through declines in occupancy. Although declines in occupancy can indicate a reduction in local abundance when survey efforts are consistent over time (Bigley and Franklin 2004), a stable occupancy rate may not necessarily indicate that a population is stable.

Higley and Mendia (2013) observed inflated rates of occupancy on the Hoopa Valley Indian Reservation, and suggested that if owls are not color banded, it may be difficult to interpret stable occupancy rates. The authors believe that inflation of observed occupancy rates may be more likely in areas where Barred Owls are present and displace Spotted Owls:

“Furthermore, because our owls are color banded, we know that they are being observed in more than one territory per season... They are moving vast distances (several miles). Due to this movement, we may be seeing an inflated occupancy (use) rate on the landscape that is well above the actual rate. If this behavior exists in study areas without color-banded owls, there would be no way to determine whether owls in multiple sites were in fact the same individual.”

Although an evaluation of occupancy rates has not been included in previous demographic analyses, the authors of the most recently completed analysis note that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning, and few territorial owls could be found on some of the study areas in 2008 (Forsman et al. 2011). This is an important consideration in interpreting results of the demographic analysis because estimates of fecundity and survival rates are independent of population size. The estimated rates are averages for all owls in a study area and so do not incorporate any measure of population size. If a study area experiences a declining number of territorial owls, which on average are experiencing reductions in rates of fecundity, the result will be far fewer owls produced each year. Even if Northern Spotted Owls at a given study area experience stable rates of fecundity over time, areas with declining occupancy rates will produce fewer young overall. This phenomenon might also explain the relatively weak effect of Barred Owls on fecundity at some study areas (see discussion of Barred Owl in Threats section). If Northern Spotted Owls become displaced by Barred Owls, they are less likely to be detected (either because of increased mortality or because they are non-territorial and non-responsive to calls). Any Northern Spotted Owls not displaced may continue to breed at historic levels, resulting in no detectable reduction in fecundity on average, or they may breed at some unknown level in sub-prime habitat and remain undetected. However, the net effect is that fewer Northern Spotted Owls are produced (Forsman et al. 2011).

In order for estimates of occupancy to be valid, survey efforts must be consistent over time and the detection probability (the probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead to high variation in detection probability which can skew estimates of occupancy if not accounted for. Ideally the owl population would also be banded in order to address the concern of inflated occupancy rates observed by Higley and Mendia (2013), at least in areas where Barred Owl is present. The ongoing demographic analysis using data from the eleven demographic study areas and covering all survey years through 2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have declined at all three California study areas, with 32-

Comment [JEH11]: I do not see this explained below. If study areas outside of CA are down to very few or no NSO, this absolutely needs to be discussed in this document since it provides an insight into what is likely coming to CA. I.e., the extirpation of NSO in some study areas is due to Barred Owls.

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1483 37% declines from 1995-2013 (Dugger et al. in review). All demographic study areas in Washington and
1484 Oregon have also experienced declines in occupancy, which is consistent with previous reports from
1485 these areas (Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011, Davis et al. 2013). Occupancy rates in
1486 Washington have declined by as much as 74% (Dugger et al. in review). Occupancy rates are a balance
1487 between rates of local territory extinction and rate of colonization. Barred Owls were shown to have a
1488 strong effect on occupancy by increasing the local territory extinction rate (Dugger et al. in review).
1489 There is also some evidence of that Northern Spotted Owl will not reoccupy empty sites if Barred Owls
1490 are present. Preliminary results also show a positive effect of habitat on colonization rates, and a
1491 negative effect of habitat in the core area on extinction rates (i.e. less habitat in the core area leads to
1492 higher extinction rate) (Dugger et al. in review).

1493 Outside of the three California demographic study areas, studies that have compiled robust datasets
1494 suitable for evaluation of Spotted Owl site occupancy in California are rare. In the southern Cascades
1495 and interior Klamath provinces of California, where there are no demographic study areas, Farber and
1496 Kroll (2012) compiled data from 1995-2009 using a consistent and rigorous annual survey effort at 63
1497 Northern Spotted Owl sites. Occupancy modeling showed that simple and pair Spotted Owl occupancy
1498 probabilities declined approximately 39% over the 15 year period; site occupancy for any owl declined
1499 from 0.81 (0.59–0.93) to 0.50 (0.39–0.60), and pair occupancy declined from 0.75 (0.56–0.87) to 0.46
1500 (0.31–0.61). In addition to providing estimates of occupancy from the interior of the range in California
1501 that is relatively understudied, this study also provides a rigorous assessment of occupancy trends on
1502 private timberlands.

1503 As an example of declining populations at California demographic study areas, the number of observed
1504 owls on NWC has declined from a high of 195 owls in 1992 to low counts of 62-67 owls since 2012
1505 (Franklin et al. 2015). At HUP, the number of owls observed between 1992 and 2006 was between 60-70
1506 owls each year; a steep decline since then has resulted in only 30 owls observed in 2013 (Higley and
1507 Mendiola 2013). At the GDR density study area, the number of occupied sites declined from about 120-
1508 140 sites for years 1992-2004 to just over 80 occupied sites in 2008 (exact numbers not available; GDRC
1509 2015). A partial recovery in number of occupied sites led to about 110 occupied sites by 2012; the
1510 authors attributed this increase to removal of Barred Owls and an increase in suitable habitat (GDRC
1511 2015). Several study areas north of California have also undergone dramatic declines.

1512 In the 97,000 acre Redwood National and State Parks, as many as 40 Northern Spotted Owl activity
1513 centers were identified during the 1990s. Occupancy rates are not available for the parks. However, by
1514 2001 a large proportion of activity centers had become inactive, and subsequent intensive surveys
1515 revealed that most historical Spotted Owl territories now appear to be occupied by Barred Owls
1516 (Schmidt 2013). Data through ~~2012-2014~~ indicated that at least ~~58-56~~ Barred Owl sites occurred within
1517 the parks, not including areas with single detections of Barred Owls. ~~In 2012~~ During 2013-2014, ~~four~~
1518 Northern Spotted Owls were detected at ~~just four territories~~ three separate sites in the parks, with only
1519 one pair observed; ~~this was also the second consecutive year with no known reproduction of Northern~~
1520 ~~Spotted Owl in the parks~~ the last Northern Spotted Owl juvenile known to have been produced in the
1521 parks was in 2010 (Schmidt 2013, 2015). It appears that this Northern Spotted Owl population has been
1522 nearly extirpated in the parks, likely due to the rapid increase of Barred Owls (Schmidt 2015).

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1523 In contrast to the above studies at demographic study areas and at other well-monitored areas that
1524 showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the
1525 study area, several industrial timber companies have concluded that Northern Spotted Owl occupancy
1526 rates have been stable on their lands, and that this indicates stable populations (Calforests 2014). In
1527 2014, the California Forestry Association hosted a Northern Spotted Owl Science Forum, to which
1528 members of the association were invited to present on monitoring efforts and status of Spotted Owls on
1529 their property. Twelve landowners, timber management companies, and non-profit groups presented
1530 on various aspects of timber operations as they relate to Northern Spotted Owls. Presentations included
1531 data on Northern Spotted Owl surveys, numbers, and population parameters, although the information
1532 presented varied by participant. Reports on estimated occupancy rates were included in many
1533 presentations and are summarized in Table 8 for nine companies.

1534 As discussed above, valid estimates of occupancy require consistent survey efforts over time, and
1535 modeling of occupancy rate must take into account detection probability. These requirements were
1536 rarely met in the occupancy estimates and trends reported by the timber companies (Calforests 2014).
1537 There is no standardized monitoring protocol used across the timber companies, and methods
1538 employed have been highly variable. In some cases, the level of detail at which methods are described
1539 does not allow for evaluation of occupancy estimates.

1540 Of nine companies reporting on some aspect of occupancy on their ownership, five reported a stable
1541 trend in occupancy with one company reporting that the population size is variable. Two companies
1542 reported a mix of stable, declining, or increasing occupancy, depending on the time period or the
1543 portion of the owl population assessed. In most cases the companies have reported on counts of
1544 occupied sites or on naïve estimates of occupancy (the proportion of surveyed sites that are occupied in
1545 a given year) without consideration of detection probability. Counts of occupied sites and detection
1546 probability are both dependent on survey effort. An example of this can be seen in data submitted by
1547 Mendocino Redwood Company, which shows a correlation between survey effort and estimates of
1548 occupancy.

1549 Green Diamond Resource Company, as a participant in the rangewide coordinated demographic studies
1550 since 1990, has the longest history of banding and monitoring work among the companies. Results from
1551 Green Diamond Resource Company are included in the demography section. Although results on
1552 occupancy modeling are preliminary, modeling revealed a more than 30% decline in occupancy from
1553 1995-2013 (Dugger et al. in review). A reduction in the rate of decline in recent years was attributed to
1554 the removal of Barred Owl from portions of the study area.

1555 Humboldt Redwood Company also has a fairly long history of monitoring, with consistent methods being
1556 used since 2002 and banding being conducted since 2003 as part of the HCP monitoring program (HRC
1557 2014). Monitoring under the Humboldt Redwood Company HCP samples a subset of the land ownership
1558 in each year. Twenty percent of lands are surveyed each year, with the entire property surveyed every
1559 five years. However, core sites are monitored annually, including determination of occupancy, whereas
1560 other sites are sampled on a rotating basis. Core sites were established to represent activity centers that
1561 have had a history of occupancy and reproduction, and the HCP provides higher habitat retention

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requirements for these core sites. Therefore, sites which are monitored annually are those which meet minimum habitat requirements and have a higher history of use by Northern Spotted Owl, resulting in a biased sample. The sampling scheme therefore results in biased estimates of occupancy for the ownership as a whole. Also, because the non-core sites are sampled on a rotating basis, a different set of sites is sampled each year. It is unclear how this rotating sampling scheme may affect reported trends in occupancy. The sampling scheme included in the Humboldt Redwood Company HCP has the benefits of less intensive annual survey requirements (*i.e., reduced cost and harassment of spotted owls*) and the ability to focus survey effort on sites with upcoming timber harvest or other management actions in order to meet the requirements of the HCP, but limits the ability to accurately determine occupancy rate for the ownership as a whole.

Campbell Global, L.L.C. manages timber lands for multiple owners, and reported on occupancy rates for two ownerships in Mendocino County (Calforests 2014). All known active activity centers were surveyed annually to determine occupancy status. Occupancy was first presented using simple count data for years 2000-2013, with no apparent trend in occupancy over time. The Spotted Owl population was reported to be dynamic but stable on these ownerships. Campbell Global also presented preliminary results of modeled occupancy dynamics (including estimation of detection probability) using data from the same ownerships from 1990-2010. Modeling showed that occupancy probabilities for single Spotted Owls began to decline in 2003. Pair occupancy declined by 16-30% during the initial portion of the time period before stabilizing in 1997. These results show how simple counts or naïve estimates of occupancy will not necessarily reflect true occupancy rates.

The Mendocino Redwood Company is the only other company to model occupancy rates taking into account detection probability (Calforests 2014). As with the lands managed by Campbell Global, L.L.C., when occupancy was presented using counts or naïve estimates there was no apparent trend (years included were 2001-2013). However, when occupancy modeling was conducted for a subset of years 2001-2008, a slight decline in occupancy was found. Occupancy modeling was not conducted on data from more recent years.

The variability in methods used by companies, the tendency to report on counts or naïve estimates of occupancy without consideration of detection probability, the sometimes inconsistent methods used over time, along with the sometimes limited description of methods, makes it difficult to interpret the reported occupancy rates and trends for most companies. This leads to some difficulty in comparing reported rates in timber company reports to other published estimates of occupancy and does not support a strong finding that occupancy rates have been stable across these ownerships over time.

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1595 **Table 8.** Occupancy estimates as presented in the Northern Spotted Owl Science Compendium in 2014 by
1596 participating timber companies with ownership in the range of the Northern Spotted Owl in California. See text for
1597 caution in interpreting these results.

Company	Pair Occupancy in 2013	Reported Occupancy Trend
Humboldt Redwood Company (Humboldt County)	0.85 (pairs only)	Stable
Sierra Pacific Industries (mainly Siskiyou and Shasta counties)	No rate provided, reported 48 known sites occupied	Stable
Conservation Fund (Mendocino and Sonoma counties)	No rate provided, reported 23 known sites occupied	Stable
Michigan-California Timber Company (Siskiyou County)	0.48	Stable
Green Diamond Resource Company (Humboldt and Del Norte counties)	0.83	1998-2008 Declining 2009-2011 Increase ¹
Crane Mills (mainly Tehama and Shasta counties)	No rate provided, reported 38 known sites occupied	No trend in occupancy noted
Mendocino Redwood Company (Mendocino and Sonoma counties)	0.69	Stable
Fruit Growers Supply Company (mainly Siskiyou County)	Approximately 0.95	Variable
Campbell Global (Mendocino, Siskiyou and Shasta counties)	>0.85 and >0.80 (singles) >0.85 and >0.70 (pairs) (estimates from 2010 occupancy analysis on two ownerships in Mendocino County)	Declining Stable

¹ The increase in occupancy starting in 2009 was attributed to the start of Barred Owl removals from the study area.

1600 Source-Sink Dynamics

1601 Pulliam (1988) was the landmark publication on source-sink population dynamics. Since then,
1602 application of source-sink dynamics has been applied within many ecological studies to better
1603 understand movement (e.g., dispersal) interactions on the landscape while accounting for birth and
1604 death rates within population segments. Source populations are those in which reproduction exceeds
1605 carrying capacity thereby providing a surplus of individuals, whereas sink populations are those where
1606 mortality exceeds local reproduction (Pulliam 1988, Dias 1996, Watkinson and Sutherland 1995).
1607 Pseudo-sinks are populations that those populations that may be viable, but movement dynamics are
1608 difficult to distinguish based on complicated demographics and habitat connectivity (Watkinson and
1609 Sutherland 1995). These source-sink dynamics have been linked to habitat quality, generally with high

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quality habitat producing source populations, and low quality habitat producing sink populations (Dias 1996). Protected areas may serve different functions for vulnerable species depending on habitat quality and connectivity (Hansen 2011). Understanding source-sink populations can give us insight into appropriate and effective management actions that may benefit species habitat and populations at a local or range-wide level. For the Northern Spotted Owl, such principles are key to understanding connectivity (quality and function) between populations and how these populations may affect one another.

By applying source-sink modeling techniques and utilizing the immense amount of data available on Northern Spotted Owl life history and demography, Schumaker et al. (2014) characterized Northern Spotted Owl movement dynamics between modeling regions and physiographic provinces noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011a). For California, the Northern Spotted Owl populations within the Klamath region (Klamath West and Klamath East modeling regions; California Klamath physiographic province) and the Inner California Coast Range modeling region were identified as source populations, while the California Coast Range and California Cascade physiographic provinces were identified as sink populations (Table 9). Source-sink strength was substantial for the East Cascade South modeling region (sink), Klamath East region (source), Inner California Coast region (source), California Coast province (sink), and California Klamath province (source).

Table 9. Source and sink attributes within modeling region and physiographic province found in California (adapted from Table 2 in Schumaker et al. 2014). Includes percent of modeled range-wide population for each location, whether the location is a source or sink, and the strength of the sink/source as a percent of the best range-wide source or worst range-wide sink.

Location	Percent of population	Source or Sink	Source-Sink Strength
<i>Modeling Regions</i>			
East Cascade South	3.8	Sink	100
Redwood Coast	16.4	Sink	28.1
Klamath West	20.0	Source	51.1
Klamath East	17.1	Source	97.9
Inner California Coast	21.7	Source	100
<i>Physiographic Provinces</i>			
California Coast Range	16.6	Sink	100
California Cascades	2.8	Sink	35.9
California Klamath	36.4	Source	100

Schumaker et al. (2014) evaluated movement and contribution to overall population growth rate within modeling region and physiographic province source locations range-wide. Data for source locations in California is summarized in Table 10 and graphically in Figure 8. Klamath modeling regions (Klamath West and Klamath East) provided a flux of individuals within (e.g., Klamath West to Klamath East), and to the Cascade modeling regions (East Cascade South and West Cascades South), Redwood Coast, and Oregon Coast. Percent of net flux was most notable from Klamath East to East Cascade South regions. The Inner California Coast modeling region provided a flux of individuals to Klamath and East Cascade South regions. The California Klamath province was identified as a source provided a flux of individuals

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1640 to the California Coast Range, California Cascades and Oregon Klamath provinces, with net flux most
1641 notable to the California Coast Range province.

1642 **Table 10.** Net Flux and $\Delta\lambda^R$ for modeling region and physiographic province source locations in California (adapted
1643 from Table 3 in Schumaker et al. 2014). Net Flux represents movement from one location to another. $\Delta\lambda^R$
1644 represents the change in overall population growth rate.

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
<i>Modeling Regions</i>			
Klamath West	Redwood Coast	36.2	3.9
	Oregon Coast	49.5	45.9
	Klamath East	12.7	19.1
Klamath East	East Cascade South	100	85.1
	West Cascades South	36.0	27.4
Inner California Coast	Klamath West	44.4	28.3
	Klamath East	19.7	18.4
	East Cascades South	30.4	22.4
<i>Physiographic Provinces</i>			
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

1645
1646 Schumaker et al. (2014) results suggest that California's population of Northern Spotted Owls is a
1647 significant component of and source to the range-wide population. As a source, the Klamath region
1648 populations provide a source of owls to sink populations on the Coast and Cascade ranges. This concept
1649 is central to protection of owl habitat, especially dispersal habitat, for the continued persistence of
1650 Northern Spotted Owls across their range.

Existing Management

Land Ownership Patterns in Northern Spotted Owl Range

1654 The laws and regulations governing management of forests in the range of the Northern Spotted Owl
1655 vary depending on ownership. For this reason, the following discussion on existing management is
1656 partitioned based on ownership, with lands governed by a common set of regulations. In general,
1657 federal timberlands in the range of the Northern Spotted Owl are governed by the NWFP, with some
1658 federal ownership subject to more restrictive management (e.g., National Parks). Although tribal lands
1659 are subject to federal regulations for timber management, the tribes in the range of the Northern
1660 Spotted Owl in California have developed Forest Management Plans (FMPs) and are discussed
1661 separately. Nonfederal lands in California must comply with the Forest Practice Rules for commercial
1662 timber harvest. There are several options for complying with the Forest Practice Rules when developing
1663 a THP depending on several factors including, but not limited to, size of ownership, presence of Spotted
1664 Owl activity centers, and qualification for an exemption. We present these options below and discuss
1665 the most important options in greater detail.

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Federal lands contain less than half of the total forest land in the range of the Northern Spotted Owl (Mouer et al. 2011). Of an estimated 14.3 million acres of forested lands within the Northern Spotted Owl range in California, 6.4 million acres are publicly owned and 7.8 million acres are privately owned (2.3 million acres industrial and 5.5 million acres non-industrial) (Calforests 2013). Federal lands in the Northern Spotted Owl range in California are more concentrated in the interior portion of the range, with most USFS and BLM land occurring in the Klamath and Cascades provinces (Figure 9). The majority of the California Coast Province is under private ownership, though large tracts of public land occur along the coast, including both State and National parks. The most interior portion of the Northern Spotted Owl range in California (Cascades and eastern portion of Klamath provinces) has a combination of federal and private land, sometimes in a checkerboard pattern as a result of historical railway land grants (Figure 9). Tribal lands in California collectively represent 167,401 acres in the range of the Northern Spotted Owl and are mostly within the Coast Province and the western portion of the Klamath Province.

Critical Habitat Designation

In 2012, the USFWS revised the critical habitat designation for the Northern Spotted Owl (USFWS 2012). The purpose of critical habitat is to designate land distributed within the entire range of the Northern Spotted Owl that provides “features essential for the conservation of a species and that may require special management”, which includes forest types supporting the needs of territorial owl pairs throughout the year, including nesting, roosting, foraging, and dispersal habitat (USFWS website - <http://www.fws.gov/oregonfwo/species/data/northernspottedowl/CriticalHabitat/default.asp>). Critical habitat was identified using a modeling framework that considered both habitat requirements and demographic data, and considered uncertainties such as impacts of Barred Owl, climate change, and wildfire risk. Range wide, 9.29 million acres of critical habitat is on federal land and 291,570 acres is on state land. All private lands and the majority of state lands were excluded from the designation. A map of critical habitat for California is shown in Figure 10, which includes 2,014,388 acres on federal land, and 49,542 acres on state land. For management purposes, critical habitat only affects federal actions and do not provide additional protection on non-federal lands, unless proposed activities involve federal funding or permitting. The critical habitat designation encourages conservation of existing high-quality Northern Spotted Owl habitat, and active management in potential and existing owl habitat to restore natural processes and increase forest resiliency to perturbations (USFWS 2012).

Federal Lands

Northwest Forest Plan

In the early 1990s, concern was raised regarding the adequacy of federal plans to protect the Northern Spotted Owl. Litigation resulted in a court injunction on harvest of owl habitat (mature and old-growth forest). In 1993, President Clinton directed the Forest Ecosystem Management Assessment Team (FEMAT) to develop long-term management alternatives for maintaining and restoring habitat conditions to maintain well-distributed and viable populations of late-successional- and old-growth-

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related species. The FEMAT was instructed to maintain and restore habitat conditions for the Northern Spotted Owl (as well as the Marbled Murrelet). The FEMAT was also instructed to maintain and restore habitat conditions to support viable populations, well-distributed across current ranges, of all species known or reasonably expected to be associated with old-growth habitat conditions; and to maintain or create a connected, interactive, old-growth forest ecosystem on federal lands (FEMAT 1993; Thomas et al. 2006). In developing alternatives, the members of FEMAT relied heavily on recently completed conservation assessments, including a regional conservation strategy for the Northern Spotted Owl (Thomas et al. 1990). The analysis of the FEMAT alternatives in a final supplemental environmental impact statement (USDA and BLM 1994a) led to adoption of the land-allocation strategy contained in the record of decision (USDA and BLM 1994b), hereinafter referred to as the Northwest Forest Plan. The NWFP amended nineteen existing USFS and seven BLM resource management plans within the range of Northern Spotted Owl. The intention of the NWFP is to improve current conditions and alter past practices that were detrimental to late-successional species by protecting large blocks of remaining late-successional and old-growth forests, and to provide for the regrowth and replacement of previously harvested late-successional forest stands. To help facilitate decision-making and issue resolution during the implementation of the NWFP, the Regional Ecosystem Office was formed and is made up of members from USFS, BLM, National Park Service (NPS), and Environmental Protection Agency (EPA).

The NWFP covers approximately 24 million acres of federal land within the range of the Northern Spotted Owl, about 67% of which are allocated in one of several “reserved” land use designations (see discussion of designations and Table 11). In California, approximately 3.5 million acres of federal lands fall under the NWFP as reserved land. This is approximately 6 percent of the 57 million acres of forested habitat within the Northern Spotted Owl’s California range. Reserved lands are intended to support groups of reproducing owl pairs across the species’ range. Unreserved land is defined as the federal land between reserved lands and is intended to provide recruitment of new owls into the territorial populations and is important for dispersal and movement of owls between larger reserves.

Table 11. Land-use allocations in the Northwest Forest Plan (adapted from Thomas et al. 2006)

Land-use allocation	Approximate Acres (%)
Congressionally reserved areas	7,323,783 (30)
Late-successional reserves	7,433,970 (30)
Managed late-successional reserves	102,242 (1)
Adaptive management areas	1,522,448 (6)
Administratively withdrawn areas	1,477,730 (6)
Riparian reserves	2,628,621 (11)
Matrix	3,976,996 (16)
<i>Total</i>	<i>24,465,790 (100)</i>

Reserved land includes late-successional reserves (LSRs), managed late-successional areas (managed LSAs), congressionally reserved lands, and larger blocks of administratively withdrawn lands. The LSRs cover about 30% of the NWFP area and were located to protect areas with concentrations of high-quality late-successional and old-growth forest on federal lands and to meet the habitat requirements of the Northern Spotted Owl (Thomas et al. 2006). Most LSRs were designed to accommodate at least 20 pairs of Northern Spotted Owls (FEMAT 1993). Timber harvesting is generally prohibited in LSRs.

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1735 However, silviculture treatments (including thinning in stands less than 80 years old west of the
1736 Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit
1737 the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging
1738 is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events
1739 such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that
1740 were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National
1741 Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district
1742 plans as being withdrawn from timber production and include recreational and visual areas, back
1743 country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily
1744 in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with
1745 smaller amounts of reserved lands on the coast (Figure 11).

1746 Unreserved land includes the matrix, adaptive management areas (AMAs), riparian reserves, small tracts
1747 of administratively withdrawn lands, and other small reserved areas such as 100-acre owl core areas.
1748 The matrix represents the federal land not included in any of the other allocations and is the area where
1749 most timber harvesting and other silviculture activities occur. However, the matrix does contain non-
1750 forested areas as well as forested areas that may be unsuited for timber production. Three of the major
1751 standards and guidelines for matrix land management are: (1) a renewable supply of large down logs
1752 must be in place; (2) at least 15% of the green trees on each regeneration harvest unit located on
1753 National Forest land must be retained; and (3) 100 acres of late-successional habitat around owl ACs
1754 must be protected (USDA and BLM 1994b). Timber harvesting is allowed within AMAs and like the
1755 matrix lands, AMAs are subject to the standards in the NWFP and in individual forest and district plans.
1756 Riparian reserves are a system of reserves defined by a set distance on each side of perennial and
1757 intermittent streams (Thomas et al. 2006) and may provide dispersal habitat for Northern Spotted Owls.

1758 Standards and guidelines for the management of both reserved and unreserved lands are described in
1759 the Record of Decision associated with the NWFP (USDA and BLM 1994b, Attachment A). A summary of
1760 management on each land use designation is provided below.

1761 Late Successional Reserves:

1762 Before habitat manipulation activities occur on LSRs, management assessments must be prepared.
1763 These assessments include a history and inventory of overall vegetative conditions, a list of identified
1764 late-successional associated species existing within the LSR, a history and description of current land
1765 uses within the reserve, a fire management plan, criteria for developing appropriate treatments,
1766 identification of specific areas that could be treated under those criteria, a proposed implementation
1767 schedule tiered to higher order plans, and proposed monitoring and evaluation components to help
1768 evaluate if future activities are carried out as intended and achieve desired results. The following
1769 standards must be followed for timber management activities in LSRs:

- 1770 • West of the Cascades – No timber harvest is allowed in stands over 80 years old. Thinning (pre-
1771 commercial and commercial) may occur in stands up to 80 years old in order to encourage
1772 development of old-growth characteristics.

Comment [JEH12]: Unreserved lands includes riparian reserves, administratively withdrawn lands, and small reserved areas? Sounds like possibly incorrect, suggest you recheck this definition.

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- East of the Cascades and in California Klamath Province – Silviculture activities should be designed to reduce catastrophic insect, disease, and fire threats. Treatments should be designed to provide fuel breaks but should not generally result in degeneration of currently suitable owl habitat or other late-successional conditions. Risk reduction activities should focus on young stands but activities in older stands may be undertaken if levels of fire risk are particularly high.
- Salvage in disturbed sites of less than 10 acres is not appropriate. Salvage should occur only in stands where disturbance has reduced canopy closure to less than 40%. All standing living trees should be retained, including those injured (e.g., scorched) but likely to survive. Snags that are likely to persist until late-successional conditions have developed should be retained. Appropriate levels of coarse woody debris should be retained. Some salvage will be allowed when it is essential to reduce fire risk or insect damage to late-successional forest conditions.

Managed Late Successional Areas:

Innovative silviculture techniques may be applied in managed LSRs. Proposed management activities are subject to review by the Regional Ecosystem Office, although some activities may be exempt from review. Within managed LSRs, certain silviculture treatments and fire hazard reduction treatments are allowed to help prevent complete stand destruction from large catastrophic events such as high intensity, high severity fires; or disease or insect epidemics. Managed LSAs should have management assessments as described for LSRs. Standards and guidelines for multiple-use activities other than silviculture are the same as for LSRs.

Congressionally Reserved Lands:

These lands are managed according to existing laws and guidelines established when the lands were set aside, and are generally managed to preserve natural resources (e.g., The National Park Service Organic Act of 1916, the National Parks Omnibus Management Act of 1998).

Administratively Withdrawn Areas:

There are no specific timber/silviculture standards and guidelines associated with administratively withdrawn areas. These areas have been identified as withdrawn from timber production in forest or district plans.

Riparian Reserves:

Riparian Reserves are managed to meet objectives of the Aquatic Conservation Strategy to help protect fish habitat and restore water quality. Timber harvest is prohibited within riparian reserves, including fuelwood cutting and salvaging (although some exceptions are made). Fuel treatment and fire suppression strategies and practices implemented within these areas are designed to minimize disturbance.

Matrix Lands:

Matrix lands are open to timber harvest subject to the standards in the NWFP and in the individual forest and district plans. The objective for Matrix lands is to “provide coarse woody debris well distributed across the landscape in a manner which meets the needs of species and provides for ecological functions” (USDA and BLM 1994b). Standards for Matrix lands in the NWFP include:

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- Coarse woody debris that is already on the ground is retained and protected from disturbance to the greatest extent possible during logging and other land management activities that might destroy the integrity of the substrate.
 - Retention of at least 15% of the area associated with each cutting unit (stand).
 - In general, 70% of the total area to be retained should be aggregates of moderate to larger size (0.5 to 2.5 acres or more) with the remainder as dispersed structures (individual trees, and possibly including smaller clumps less than 0.5 acres). Patches and dispersed retention should include the largest, oldest live trees, decadent or leaning trees, and hard snags occurring in the unit. Patches should be retained indefinitely (i.e., through multiple rotations to provide support for organisms that require very old forests).
 - 100 acres of the best Northern Spotted Owl habitat must be retained as close to the nest site or owl activity center as possible for all known activity centers located on federal lands in the matrix and AMAs. These areas are managed in compliance with LSR management guidelines and are to be maintained even if Northern Spotted Owls no longer occupy them.

1828 Adaptive Management Areas:

1829 AMAs were intended to be focal areas for implementing innovative methods of ecological conservation
1830 and restoration, while meeting economic and social goals. Although there have been some successes in
1831 experimentation, most AMAs have been managed similarly to Matrix lands (Thomas et al. 2006). The
1832 NWFP established 10 AMAs, two of which are in California: Goosenest in northeastern California and
1833 Hayfork, which is located mostly in the Klamath province. One of the primary goals of the Goosenest
1834 AMA is to investigate means of accelerating the development of late-successional forest properties in
1835 pine forests. Mechanical treatments (forest thinning) and prescribed fire have been used experimentally
1836 to evaluate effect on development of late-successional forest properties in pine forests (Ritchie 2005).
1837 The emphasis for Hayfork is to investigate effects of forest management practices on the landscape,
1838 including partial cutting, prescribed burning, and low-impact approaches to forest harvest.

1839 Standards and guidelines for LSRs and Congressionally Reserved Areas are followed where they fall
1840 within AMAs.

1841 *Section 7 Consultations*

1842 Section 7 of the Endangered Species Act requires all federal agencies to consult with the USFWS to
1843 ensure that any timber management action authorized, funded, or carried out by federal agencies is not
1844 likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical
1845 habitat (16 U.S.C. § 1536 subd. (a); 50 C.F.R. § 402). Section 7 requires the permitting instrument (i.e.,
1846 biological opinion or letter of concurrence) to include measures to minimize the level of take to
1847 Northern Spotted Owl. Examples of take minimization measures may include:

- 1848
- 1849
- Restricted use of ~~noise-generating~~ heavy equipment during the breeding season
 - Retention of larger trees in owl nesting/roosting and foraging habitat

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- Retention of ~~large snags, down woody material, and hardwoods and down logs within~~ thinning units
- ~~Retention of hardwoods~~ Maintenance of existing nesting/roosting, and foraging habitat within core areas and home ranges, and minimizing activities in nest groves
- ~~Limited thinning within Riparian Reserves~~
- Monitoring and surveys for Northern Spotted Owl throughout projects

Forest Stewardship Contracting

The Agricultural Act of 2014 (“Agricultural Act of 2014, Section 8205, Stewardship End Result Contracting Projects”) grants the USFS and BLM authority to enter into stewardship contracting with private persons or public entities to perform services to “achieve land management goals for the national forests or public lands that meet local and rural community needs” (USFS 2009). Agreements allow contractors to remove forest products (goods) in exchange for performing restoration projects (services), the cost of which is offset by the value of the goods. Agreements may extend for up to 10 years.

Since the new authority became law, the USFS has awarded more than 30 stewardship projects. It is unknown how many USFS stewardship projects are in California. There are some inconsistencies in information regarding the number of BLM stewardship projects. The BLM Stewardship Contracting Fact Sheet (http://www.blm.gov/style/medialib/blm/wo/Planning_and_Renewable_Resources/0.Par.13217.File.dat/stcontrBLM_Fact0115.pdf) lists two stewardship projects that do not occur in California. However, the BLM website (http://www.blm.gov/wo/st/en/prog/more/forests_and_woodland/0.html) lists three forest stewardships in California: Weaverville Community Forest, South Knob, and Hobo Camp.

Bureau of Land Management

The standards and guidelines from the NWFP apply except where existing resource management plans are more restrictive or provide greater benefits to late-successional forest related species.

Headwaters Forest Reserve

Headwaters Forest Reserve is located in the north coast region of California and was purchased by the Secretary of Interior and the State of California in 1999 to preserve a large stand of old-growth redwood forest. The Headwaters Forest Reserve Resource Management Plan (USDOI et al. 2003; USDOI and BLM 2004a) was developed with the goal to restore and maintain ecological integrity and to study ecological processes within the Reserve to improve management. Recreation and other management activities are constrained as necessary to be consistent with that primary goal. Old-growth forest habitat within the Reserve is managed to leave those systems undisturbed as core areas of optimal habitat. Second-growth forests are managed using tree thinning for restoration of old-growth characteristics. Priority is given to revegetating watershed restoration sites in old-growth areas and to treating harvested stands with old-

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1886 growth remnants. Harvested stands that comprise early-mature and older seral stages (i.e., stands with
1887 an average stem diameter over 12 inches) are generally not thinned. Density-management treatments
1888 do not yield commercial forest products; all biomass is left on-site and may be lopped and scattered,
1889 piled and burned, or chipped. Chain saws, mechanical brush cutters, and chippers may be used.
1890 Permanent or temporary roads or skid trails are not developed for access for treatment sites, but
1891 temporary access routes may be developed where they will be subsequently removed during watershed
1892 restoration activities.

1893 The desired outcome for Northern Spotted Owl is protection of existing habitat and expansion of
1894 suitable habitat for nesting, roosting, foraging, and dispersal habitat at the Reserve. The Resource
1895 Management Plan allows for the restoration of up to 2,757 acres of previously harvested stands. No
1896 suitable habitat for Northern Spotted Owl is to be removed or degraded during watershed restoration,
1897 forest restoration, or trail development. To the extent practicable, activities will be buffered from
1898 Northern Spotted Owl nesting habitat during the period of February 1 through July 31 by the use of
1899 vegetative screening or topographic screening and establishment of seasonal operating periods or a
1900 distance buffer of up to 0.25 mile. Off trail hiking is prohibited year-round.

1901 Fuels in second-growth forests are managed through tree thinning with materials lopped and scattered,
1902 piled and burned, or chipped; broadcast burning is not employed within the Reserve. Fuels are not
1903 managed in old-growth forests and generally not in second-growth forest once they achieve early-
1904 mature seral stage. Fire suppression uses a minimum-impact strategy. In second-growth forests dozers
1905 may be used; resource damage will be minimized and full rehabilitation of dozer fire lines will be
1906 required after fire suppression. In old-growth forests road access will be limited to existing road
1907 systems; hand crews or helicopter bucket drops may be deployed to attempt to contain fire.

1908 King Range National Conservation Area

1909 The King Range National Conservation Area (NCA) is located along the northern California coast about
1910 sixty miles south of Eureka and 200 miles north of San Francisco. The King Range NCA Management Plan
1911 (USDOI and BLM 2004b; USDOI and BLM 2005) applies to 68,000 acres of forested land. All of the
1912 forested lands in the planning area have been designated as a LSR under the NWFP, and therefore must
1913 be managed to promote late-successional forest characteristics. All active forest management activities
1914 in the Management Plan are focused only in the Front Country Zone, 25,661 acre zone representing a
1915 broad mix of uses and tools for management. Forest management activities in this zone are intended to
1916 develop more natural stand characteristics in areas that were previously harvested, improve watershed
1917 and fisheries health, and protection from wildfire risk. Some of these previously-logged areas have
1918 burned in high intensity fires, or are at risk for future fires of stand-replacing intensity. The primary goal
1919 in silvicultural treatments is to increase the Douglas-fir component in tanoak dominated stands, and
1920 “fireproof” this Douglas-fir component so that it has a greater chance to reach maturity.

1921 The Management Plan calls for the protection of sufficient Northern Spotted Owl habitat to attract and
1922 support 20 breeding pairs within the King Range NCA, as well as monitoring of known owl sites and
1923 periodic surveys in suitable habitat. At the time of the Management Plan development (2004), there

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1924 were 12-14 known Spotted Owl activity centers in the King Range NCA. No timber harvests takes place in
1925 those activity centers.

1926 *National Park Service*

1927 Redwood National and State Parks

1928 Redwood National Park was established in 1968 and was expanded in 1978. Three California state parks
1929 established in the 1920s—Prairie Creek Redwoods State Park, Del Norte Coast Redwoods State Park, and
1930 Jedediah Smith Redwoods—were included within the 1968 congressionally designated national park
1931 boundary. Since 1994, the four park units have been managed jointly as Redwood National and State
1932 Parks (RNSP) to the greatest extent possible, although the state parks are administered by the California
1933 Department of Parks and Recreation and the national park is administered by the NPS. Collectively,
1934 RNSP covers approximately 131,983 acres of land in northwest California reaching from the shoreline of
1935 the Pacific Ocean to the mountains of the Coast Range.

1936 In 2000, a joint federal-state management plan was developed to provide a clearly defined, coordinated
1937 direction for resource preservation and visitor use and a basic foundation for managing these four parks
1938 (NPS 2000a, NPS 2000b). There are nine management zones within the RNSP, each with different types
1939 and levels of use, management, and facilities that are allowed. Three zones cover most of the combined
1940 park area – the two backcountry zones (42.1% mechanized and 13.3% nonmechanized), and the
1941 primitive zone (32.6%). The backcountry zones and primitive zone have the most restricted access, and
1942 resource modification and degradation from visitor use in these zones is low. The remaining 12% of the
1943 park area is made up of six relatively small zones which are managed for various resources and for
1944 visitor operational needs.

1945 The RNSP General Management Plan (NPS 2000b) includes programs for watershed restoration,
1946 vegetation management, cultural resource management, interpretation and education, and facility
1947 development. Under the watershed restoration program, abandoned logging roads that contribute
1948 unnatural amounts of sediments into streams or threaten redwoods along park streams will be removed
1949 or treated to reduce erosion. The vegetation management program includes use of silvicultural
1950 techniques in second-growth forests to accelerate the return of characteristics found in old-growth
1951 forests and management of fire to support resource management strategies, including restoration of
1952 fire in old-growth forests.

1953 Prior to timber removal, the NPS will evaluate trees that are potential suitable nesting habitat for
1954 Northern Spotted Owl. The NPS take measures to reduce noise disturbance and loss of suitable habitat
1955 within one mile of occupied and unsurveyed potential suitable nesting habitat by operating outside the
1956 breeding season, using quiet equipment, or by implementing daily limited operating periods for heavy
1957 equipment during the breeding season. Protective buffer zones are used around known owl nest sites
1958 where visitor use activities are likely to result in disturbance.

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1959 In 1978, Congress expanded RNSP to include 38,000 acres that had been logged between 1950 and 1978
1960 using clearcut tractor logging. With the expansion of the RNSP, commercial operations including active
1961 forest management and silviculture thinning ceased which resulted in second-growth forest conditions
1962 “considered unhealthy from both a silviculture and an ecological standpoint” (NPS 2008, NPS 2009a).
1963 Many of the second-growth forest stands were primarily high-density, even-aged Douglas-fir stands with
1964 little canopy structure and no understory development. The focus of second-growth forest restoration is
1965 to reduce stand density (thinning) to promote growth of remaining trees while protecting adjacent old-
1966 growth forests, as well as maintaining water quality in riparian habitats, minimizing tanoak tree
1967 disturbance, and minimizing excessive fuel build-up on the forest floor.

1968 In 2009, the NPS planned to apply thinning prescriptions throughout 1,710 acres in the South Fork of
1969 Lost Man Creek, with the prescription dependent upon slope steepness, available road access, presence
1970 of streams and wetlands, tanoak density, and proximity to old growth forest.

1971 The USFWS issued a Biological Opinion (file number 8-14-2004-2133 81331-2008-F-00027, dated
1972 December 19, 2007) that concurred with the NPS determination that the project may affect but is not
1973 likely to adversely affect the Northern Spotted Owl. The project was expected to alter approximately
1974 1,539 acres of suitable Northern Spotted Owl habitat. However, the habitat was considered poor quality
1975 and the short-term adverse effects on owls from habitat alteration to be negligible. The project was
1976 expected to have long-term benefits for Northern Spotted Owl due to retention and protection of
1977 deformed trees and snags, and habitat improvement through acceleration of development of late-
1978 successional forest structure.

1979 In 2011, Redwood National Park completed a project to thin about 1,700 acres of second growth forest
1980 in the South Fork of Lost Man Creek (near the community of Orick) to accelerate the restoration of old-
1981 growth characteristics and functions.

1982 The RNSP General Management Plan called for preparation of a comprehensive trail and backcountry
1983 management plan to guide the development of an expanded trail system and prescribe policies and
1984 regulations for the use of backcountry areas by hikers, bicyclists, and equestrians. The Trail and
1985 Backcountry Management Plan (NPS 2009b) details the construction of seven hiking trails totaling 14.6
1986 miles, establishment of two bike trails totaling 10.3 miles, and construction of two new backcountry
1987 camps. Avoidance and minimization measures during construction include above ambient noise
1988 producing work conducted outside of the marbled murrelet noise restriction period (March 24-
1989 September 15) and Northern Spotted Owl presence surveys prior to construction (NPS and CDPR 2013).

1990 Fire management in RNSP includes suppression of wildfires, prescribed fire, mechanical fuel reduction,
1991 fire ecology research and fire effects monitoring, and fire operations planning (NPS 2010a, NPS 2010b).
1992 Fire suppression preparations include installing water tanks, preparing access roads, and removing
1993 hazardous fuels. Management actions are designed to avoid or minimize adverse effects on listed,
1994 proposed, or candidate threatened or endangered species and minimizes the effects on sensitive
1995 species. The NPS has developed guidelines to reduce or eliminate potential adverse effects on sensitive
1996 species from fire suppression in RNSP.

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1997 Point Reyes National Seashore and Muir Woods National Monument

1998 The Point Reyes National Seashore (PRNS) was established in 1962 and is located along the coast just
1999 north of San Francisco. The General Management Plan and Environmental Impact Statement for PRNS
2000 are currently under development.

2001 Due to a better understanding of the role of fire in ecosystem preservation and reducing fire risk, in
2002 2004 the NPS proposed to revise PRNS's Fire Management Plan to expand the use of prescribed fire and
2003 mechanical treatment for all lands under its management NPS 2004). In 2006, the Operational Strategy
2004 for the Fire Management Plan was published (NPS 2006a). The planning area for the Fire Management
2005 Plan includes the 70,046-acre PRNS as well as 18,000 acres of the Northern District of Golden Gate
2006 National Recreation Area. The Fire Management Plan allows up to 3,500 acres per year to be treated
2007 using prescribed fire and mechanical treatments. Measures in Northern Spotted Owl habitat include:

- 2008 • Annually identify and map areas where Spotted Owls are nesting.
- 2009 • Protect occupied and previously used nest sites from unplanned ignitions.
- 2010 • Do not conduct prescribed burns within 400 meters of an occupied or previously used nest
- 2011 site.
- 2012 • Do not conduct mechanical treatments with mechanized equipment within 400 meters of an
- 2013 occupied or previously used nest site between February 1 and July 31 (breeding season).
- 2014 • Conduct post-treatment monitoring to ascertain any impacts.
- 2015

2016 Muir Woods National Monument is managed by the NPS as part of the Golden Gate National Recreation
2017 Area. The General Management Plan Environmental Impact Statement for the Golden Gate National
2018 Recreation Area and Muir Woods was completed in 2014 (NPS 2014). The Record of Decision was
2019 expected to be completed in spring 2014 but has not been completed to date.

2020 The Fire Management Plan for Muir Woods allows up to 595 acres to be treated per year using
2021 mechanical treatments and prescribed fire (NPS 2006b). Measures to protect Northern Spotted Owl
2022 include:

- 2023 • Treatment activities or any noise generation above ambient noise levels will not occur within
- 2024 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential
- 2025 Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as
- 2026 surveys conforming to accepted protocol have determined that the site is unoccupied or non-
- 2027 nesting or nest failure is confirmed.
- 2028 • Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially
- 2029 alter the percent cover of canopy overstory and will preserve multilayered structure. When
- 2030 shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy
- 2031 will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency
- 2032 vehicle clearance.

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- 2033 • Prior to fire management activities, project areas will be surveyed for the presence of dusky
- 2034 footed woodrat nests. If feasible, woodrat nests will be protected.
- 2035 • Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a
- 2036 determination is made that the native tree presents a clear hazard in the event of a fire or
- 2037 cutting is the only option to reduce high fuel loading.
- 2038 • The fire management officer will arrange for qualified biologists to conduct post-project
- 2039 monitoring to determine short- and long-term effects of fire management actions on activity
- 2040 centers if resources are available.

2041 Tribal Lands

2042 *Hoopa Valley Indian Reservation*

2044 The Hoopa Valley Indian Reservation is the largest reservation in California encompassing 90,767 acres,
2045 and located in the northeastern corner of Humboldt County. The Hoopa Valley Tribe has recently
2046 adopted a revised Forest Management Plan (FMP) covering the period of 2011-2026 (Higley 2012). The
2047 annual allowable timber harvest has been determined to be 8.889 million board feet (MBF) net per year
2048 of conifer volume and 3.1 MBF net of hardwood volume to be harvested within the Reservation.
2049 Northern Spotted Owl habitat losses are expected from implementation of the FMP due to timber
2050 harvest, urban development, road construction, and prairie restoration. About 8,980 acres of roosting-
2051 foraging and nesting-roosting-foraging habitat are estimated to be lost to timber harvest over the period
2052 covered by the FMP. These acres will be temporarily rendered unsuitable to Northern Spotted Owl,
2053 although the FMP notes that habitat will “recover eventually to at least foraging dispersal but likely to
2054 roosting-foraging habitat...within 30-40 years because of the retention of large structures within all
2055 units” (Higley 2012). Implementation of the FMP and associated projects will result in a decline in total
2056 suitable habitat by approximately 4.4% by the end of the planning period in 2026. Dispersal habitat will
2057 be reduced by approximately 4.9% at the end of 2021 but is expected to rebound to a net reduction of
2058 0.9% by 2026.

2059 The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late
2060 successional reserves to the north, south, and east, and Redwood National Park to the northwest. The
2061 reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40
2062 pairs of owls at all times during the planning period. However, the plan notes this number of Northern
2063 Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009
2064 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl
2065 detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning
2066 in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

2067 Eight forested management units noted in the FMP will retain Northern Spotted Owl dispersal habitat.
2068 None of the forested management units will dip below 50% cover of dispersal or higher quality habitat.
2069 The lowest level of owl habitat retention will occur within the Hopkins management unit, which at 72%

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2070 at the time of the publication of the FMP, was projected to drop to 64% in 2012 and increase to 81% by
2071 2026.

2072 The FMP includes management actions to mitigate affects to Northern Spotted Owl including land
2073 allocation restrictions, requirements for structural retention within timber sale units and hardwood
2074 management guidelines, and are inclusive of:

- 2075 • The no cut land allocation includes 24,581 acres of which 21,104 acres were forested as of 2011
2076 with stem exclusion or larger size class strata including 10,134 acres of old growth.
- 2077 • 2,819 acres are allocated as reserved for threatened and endangered species. 73 acres are
2078 specifically reserved to protect Northern Spotted Owl nesting core areas.
- 2079 • Seasonal restrictions will apply to all disturbance activities resulting from logging, site
2080 preparation, stand improvement, burning, road construction or reconstruction, and watershed
2081 restoration projects, etc. within 0.25 miles of any known Northern Spotted Owl pair at least until
2082 nesting status is determined from February 1 until July 31. Activities, which modify suitable
2083 nesting/roosting habitat, such as logging, will be further restricted until September 15 of each
2084 year or until the young owls are determined to be capable of moving away from the area or the
2085 reproductive attempt has been determined to have failed. For territories that have been
2086 surveyed continually and found to be unoccupied for 2 or more years, no restrictions shall be
2087 imposed.

2088 *Yurok Indian Reservation*

2089 The Yurok Indian Reservation is located in Del Norte and Humboldt counties inclusive of one-mile on
2090 each side of the Klamath River along a 44-mile stretch. There are approximately 59,000 acres in the
2091 entire Yurok Indian Reservation, and of these, approximately 3,320 acres are forested Tribal trust lands
2092 (i.e., land that the federal government holds legal title to but the beneficial interest remains with the
2093 Tribe), and 2,171 acres are forested allotted lands held in trust (Erler 2012). The remaining lands are fee
2094 lands (i.e., land acquired by the Tribe under legal title outside the boundaries of the Reservation, and in
2095 this case is primarily owned by Green Diamond Resource Company), which are managed intensively for
2096 timber products. Total forested Tribal ownership is 36,637 acres.

2097 The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all
2098 Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for ~~intensive~~
2099 surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then
2100 dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites.
2101 The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest
2102 reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity
2103 centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl
2104 habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on
2105 disturbance activities within 0.25 mile of Northern Spotted Owl nest.

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2106 *Round Valley Indian Reservation*

2107 The Round Valley Indian Reservation encompasses about 23,200 acres in Mendocino County. More than
2108 two thirds of this area is off-reservation trust land. A total of 2,837 acres are allocated as “Available”
2109 under the Round Valley Indian Reserve FMP (Baldwin, Blomstrom, Wilkinson and Associates 2006),
2110 which means that programmed timber harvest may be allowed. As of 2006, there were eight known
2111 pairs of Northern Spotted Owl either nesting, roosting, or foraging on the Reservation. Approximately
2112 80% of the Reservation could be considered as suitable owl habitat, according to the FMP’s
2113 Environmental Assessment (2006). The FMP would impact about 13% of the 22,150 acres of suitable
2114 habitat on the Reservation. Uneven-aged forest management including single-tree and group selection
2115 is the preferred method, with a 20 year cutting cycle and 100 year rotation, although limited even-aged
2116 management is allowed in specific cases. Harvest is expected to be about 3.4 MFB/acre.

2117 **Nonfederal Land**

2118 *History of Timber Management on Nonfederal Lands and the Forest Practice Rules*

2119 The California Department of Forestry and Fire Protection (CAL FIRE; <http://www.calfire.ca.gov/>)
2120 enforces the laws that regulate logging on privately-owned lands in California. These laws are found in
2121 the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will
2122 also preserve and protect California’s fish, wildlife, forests, and streams. Additional rules enacted by the
2123 State Board of Forestry and Fire Protection (BOF) are found in state regulations and are collectively
2124 referred to as the Forest Practice Rules. The purpose of the Forest Practice Rules is to implement the
2125 provisions of the Forest Practice Act in a manner consistent with other laws, including the California
2126 Environmental Quality Act (CEQA) of 1970, the Timberland Productivity Act of 1982, the Porter Cologne
2127 Water Quality Act, and the California Endangered Species Act (CESA).

2128 CAL FIRE ensures that private landowners abide by these laws when harvesting trees. Although there are
2129 specific exemptions in some cases, compliance with the Forest Practice Act and the Forest Practice Rules
2130 apply to all commercial harvesting operations for private landowners from ownerships composed of
2131 small parcels to large timber companies with thousands of acres.

2132 A Timber Harvesting Plan (THP) is generally the environmental review document submitted by
2133 landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the
2134 steps that will be taken to prevent damage to the environment. THPs are prepared by Registered
2135 Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process
2136 substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber
2137 harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

2138 In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by
2139 the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These
2140 biologists would become the first “designated biologists” who would consult on proposed THPs.

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2141 Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules
2142 and procedures that would be adopted in the event of listing. The rules identified descriptions of
2143 Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for
2144 timber operations to avoid take. The rules called for consultations between plan proponents and
2145 Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to
2146 amend the initially adopted emergency rules; amendments to the rules occurred several times as
2147 knowledge of the Northern Spotted Owl increased and with experience gained through implementation
2148 of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and
2149 919.10 [939.10] in March 1991, which describe options and procedures that can be used in THPs to
2150 avoid take of Northern Spotted Owl or to proceed under incidental take authorization.

2151 Section 919.9 [939.9] includes subsections (a) through (g), which are procedures (referred to as
2152 “options”) among which THP submitters must select and then must follow for THPs within the range of
2153 the Northern Spotted Owl or the “Northern Spotted Owl Evaluation Area” as defined in the Forest
2154 Practice Rules, and for THPs that are situated outside of this Evaluation Area that are within 1.3 miles of
2155 known owl activity centers. The option that is selected must meet on-the-ground circumstances. The
2156 information that each option requires is to be used by CAL FIRE to evaluate whether or not the proposed
2157 timber operations under the THP would result in unauthorized Northern Spotted Owl take. Subsections
2158 (a), (b), (c) and (f) involve CAL FIRE consulting with a Spotted Owl Expert (SOE). An SOE is defined in the
2159 Forest Practice Rules as a person with requisite documented education and experience whose
2160 qualifications have been referred by CAL FIRE to USFWS or the Department for evaluation.

2161 Subsection (a) provides the project proponent the option before a THP is filed of requesting an SOE to
2162 complete a preliminary review of the proposed timber operations to evaluate whether Northern
2163 Spotted Owl take would occur. The SOE must apply the criteria for Northern Spotted Owl take avoidance
2164 specified in Section 919.10 [939.10], and must inform the project proponent whether the proposed
2165 timber operations would or would not cause take. In practice, if an SOE concludes take would be
2166 avoided, the results of such a preliminary review would be included in a THP when submitted to CAL
2167 FIRE for filing, review and approval.

2168 Subsection (b) includes a list of information the project proponent must disclose in a THP; including
2169 functional Northern Spotted Owl habitat within and outside the THP area both before and after harvest,
2170 known owl detections, information on owl surveys conducted and results and other information. It
2171 requires a discussion of how functional Northern Spotted Owl habitat will be protected according to
2172 criteria presented in Section 919.10.

2173 Subsection (c) provides the project proponent the option of obtaining from an RPF a certification to be
2174 included in the THP that Northern Spotted Owls are inferred absent from the THP area and out 1.3 miles
2175 from the THP area based on the results of surveys completed according to the USFWS survey protocol,
2176 (USFWS 2012) and the RPF’s personal knowledge and a review of information in the Northern Spotted
2177 Owl database maintained by the Department.

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2178 Subsection (d) involves the project proponent proceeding under the provisions of an incidental take
2179 permit issued by USFWS or the Department.

2180 Subsection (e) allows the project proponent to proceed with timber harvest according to the outcome of
2181 a consultation with USFWS. This outcome is memorialized in what is referred to as a “technical
2182 assistance letter” from USFWS.

2183 Subsection (f) allows the project proponent to disclose in the THP the outcome of an SOE’s preliminary
2184 review as described under Subsection (a), to demonstrate that any measures to avoid Northern Spotted
2185 Owl take recommended by the SOE have been adopted in the THP and that the proposed timber
2186 operations evaluated by the SOE remain substantially the same in the submitted THP.

2187 Subsection (g) is an option appropriate for THPs where one or more Northern Spotted Owl activity
2188 center has been located within the THP area or within 1.3 miles of its boundary. This option requires the
2189 RPF to determine and document activity center-specific protection measures to be applied under the
2190 THP and that various specified forms and acreages of functional owl habitat (nesting, roosting and
2191 foraging) will be retained post-harvest around each activity center. The minimum acreages to be
2192 retained after harvest of functional nesting, roosting and/or foraging habitat within 500 feet, 500 to
2193 1,000 feet, 0.7 mile and 1.3 miles around each activity center are specified in this subsection.

2194 Section 919.10 [939.10] of the Forest Practice Rules presents the criteria CAL FIRE is to apply to
2195 information provided in the THP and during the THP review period to make a finding as to whether or
2196 not the proposed timber operations will avoid Northern Spotted Owl take in the form of “harass, harm,
2197 pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct”, as
2198 defined under Endangered Species Act (ESA). If CAL FIRE concludes take would occur, they must provide
2199 reasons why the determination was made according to criteria presented in section 919.10 [939.10] ,
2200 what information was used in making the determination, and recommend minimum changes to the
2201 proposed THP to avoid take. According to Forest Practice Rules Section 898.2, Special Conditions
2202 Requiring Disapproval of Plans, CAL FIRE shall disapprove a THP if the THP would cause Northern
2203 Spotted Owl take prohibited by the ESA.

2204 Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were
2205 provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following
2206 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could
2207 inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol,
2208 breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly
2209 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans
2210 and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol
2211 was revised (USFWS 2012).

2212 When consultations with the USFWS were required, they consisted of a field review of the proposed
2213 THP area, an evaluation of the pre-harvest and predicted post-harvest habitat typing (its suitability for
2214 nesting, roosting, or foraging), the sufficiency of habitat retained post-harvest within 500 feet, 0.7 mile
2215 and 1.3 mile of owl ACs, and an evaluation of the adequacy of the surveys that were conducted (i.e.

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2216 timing, location, interpretation of results) and their consistency with the USFWS protocol. When
2217 appropriate, the Department designated biologists would evaluate or propose THP-specific habitat and
2218 temporal buffers that differed from standard Forest Practice Rules habitat retention and seasonal
2219 restriction requirements that would be adopted as enforceable conditions of THPs.

2220 In 1991, a curriculum was designed to train private consulting biologists who could conduct the field and
2221 document review portions of a Northern Spotted Owl consultation, although final approval from a
2222 Department designated biologist was still required. University biologists and biological consultants,
2223 along with designated Department Timber Harvest Assessment Program staff helped THP submitters to
2224 evaluate their plans with regard to potential take of Northern Spotted Owls. Workshops helped calibrate
2225 consultants, RPFs and others regarding owl life history, habitat associations, and so forth. Northern
2226 Spotted Owl consultations for most THPs were conducted by the Department designated biologists from
2227 1991 into 1997.

2228 From 1991 through 1997 the Department and to a much lesser extent, CAL FIRE staff processed
2229 Northern Spotted Owl consultations for THPs. Additionally, Department staff participated in the review
2230 of private timber company Habitat Conservation Plans, Spotted Owl Management Plans, and Spotted
2231 Owl Resource Plans. In 1994, Department staff was directed to give Northern Spotted Owl consultations
2232 its highest priority and to set aside a minimum number of days per week to address a consultation
2233 backlog. In this same year, CAL FIRE staff was directed to suspend processing of consultations.

2234 In 1995 the Department established a process for certifying “Private Consulting Biologists” (PCBs) to
2235 fully conduct Northern Spotted Owl consultations, which included approval of a consultation package,
2236 and discontinuing the need for additional approval from a Department designated biologist. However,
2237 Department staff continued to process consultations not prepared or reviewed by PCBs.

2238 Beginning in 1999, Department staff no longer processed THP Northern Spotted Owl consultations and
2239 no longer reviewed the work of private consultant biologists. Reasons for the suspension of processing
2240 included:

- 2241 • Other emerging and compelling forestry sector conservation issues required Department staff’s
2242 attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related
2243 workload).
- 2244 • The Department “Timber Harvest Assessment Program” (later to become the “Timberland
2245 Conservation Planning Program”) budget did not include funding specifically for consultations.
- 2246 • Staffing of USFWS offices with wildlife biologists had increased.
- 2247 • The Department felt CAL FIRE and USFWS staff were capable of review, approval, and
2248 assessment of THPs and NTMPs.
- 2249 • The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- 2250 • The scope, quality and conformance of owl-related information with Forest Practice Rules
2251 requirements appeared to have stabilized after approximately six years of implementation.

2252

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2253 Regardless of the suspension in consultation involvement, the Department continued to evaluate THPs
2254 with regard to potential significant impacts to Northern Spotted Owl from timber operations, and as
2255 appropriate reminded THP proponents to comply with Section 3503.5 of the Fish and Game Code. In
2256 addition, the Department continued monitoring compliance with Northern Spotted Owl-related Habitat
2257 Conservation Plan's conservation measures.

2258 At the time that the Department suspended processing of THP and Nonindustrial Timber Management
2259 Plans (NTMP) consultations (1999), the USFWS technical assistance program began. After nine years of
2260 processing technical assistance requests from applicants, the USFWS notified CAL FIRE in 2008 that
2261 technical assistance requests would have to come directly from CAL FIRE rather than the applicant.
2262 Detailed written guidance and information associated with the analysis process was provided to CAL
2263 FIRE, along with scheduled workshops, to assist in the transition from the USFWS to CAL FIRE (USFWS
2264 2008b). The guidance somewhat deviates from the Forest Practice Rules and included information
2265 needed for Northern Spotted Owl technical assistance, descriptions and appropriate uses for the 1- and
2266 2-year owl survey protocols, owl take avoidance scenarios, and the take avoidance analysis process,
2267 habitat retention criteria within 0.5, 0.7 and 1.3 mile radius from the activity center, and a description of
2268 habitat parameters (i.e., nesting/roosting/foraging habitat) for both the interior and coastal regions.
2269 Since this time, CAL FIRE has been responsible for reviewing the majority of Spotted Owl-affected THPs,
2270 and has assisted applicants and USFWS by assessing technical assistance requests if forwarded to
2271 USFWS.

2272 In 2009, the USFWS developed a white paper, Regulatory and Scientific Basis for the U.S. Fish and
2273 Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in
2274 California's Northern Interior Region, to scientifically justify why the 2008 guidance deviated from the
2275 Forest Practice Rules (USFWS 2009). The white paper recommended using a circular 0.5 mile area
2276 around activity centers as the core use area for habitat assessment and management purposes. Specific
2277 criteria within the USFWS guidelines, and how they differ from the Forest Practice Rules, are discussed
2278 in the Timber Harvest section below.

2279 The Department Timber Harvest Assessment Program was eliminated in late 2010. From a high of 33
2280 staff members state-wide in 2007, fewer than eight remained engaged in forestry environmental review
2281 and permitting in 2011. The remaining positions were assigned to other programs in the Department,
2282 and in some cases were still involved in a range of forestry-sector work (e.g., lake or streambed
2283 alteration agreements, natural community conservation plans, sustained yield plans and limited THP
2284 environmental review).

2285 In 2013, a new Department "Timberland Conservation Planning Program" (TCP) was established through
2286 a stable funding source and authorities mandated pursuant to Assembly Bill 1492 (2012), to ultimately
2287 increase staff to 41 in Department Headquarters and in four Department Regions. Today, TCP Staff
2288 members participate in THP review, process lake or streambed alteration agreements, complete species
2289 consultations (including "pre-consultations") for "sensitive species" and those that are listed or
2290 candidates for listing pursuant to CESA, review forest habitat restoration grant proposal, and other
2291 activities. In addition, as required by Assembly Bill 1492, TCP staff are mandated to and will soon embark

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on inspections of approved and completed THPs and compliance and effectiveness monitoring. Department staff members selectively review Northern Spotted Owl-related information disclosed in THPs as part of routine THP environmental review; however, with the broad suite of other mandated THP review-related responsibilities, the TCP's allocated staffing and resources are not adequate to allow staff to engage in Northern Spotted Owl consultations at the level and in ways they did in the 1990s.

Timber Harvest Management

Timber Harvest Plans

As noted previously, a THP is a document that outlines the level and type of proposed timber harvest, and details steps to be taken to prevent damage to the environment, including measures to avoid take of Northern Spotted Owl. Landowners prepare THPs following the provisions of the Forest Practice Rules, and select options for which to follow (Section 919.9 [939.9], subsections (a) through (g)). The purpose of these options is to avoid take of Northern Spotted Owl.

After reviewing all THPs within the Northern Spotted Owl range submitted to CAL FIRE in 2013, it was apparent that Forest Practice Rules section 919.9[939.9], subsections e and g (hereafter referred to as Option (e) and (g)), were the most frequently used among THPs submitted, and thus, have the greatest potential to impact owl habitat. Other THPs applied Section 919.9/939.9, subsections a, b, and d. Therefore, for THPs submitted in 2013 utilizing Option (e) and (g), we assessed each THP, available through CAL FIRE, for consistency and appropriate application regarding impact avoidance to the Northern Spotted Owl.

For the THPs assessed, proposed silvicultural prescription method and acreage was summarized by county. Silvicultural prescription methods are defined in the Forest Practice Rules, and are included in Appendix 1. In addition, for each THP utilizing Option (e) and (g), the potential impact of proposed harvest to activity centers in each option was assessed as well. Due to the different habitat retention guidance for interior and coastal THPs, the assessment conducted for interior counties were conducted only for THPs associated with activity centers within 1.3 miles of the proposed project, and the assessment for coastal counties included only THPs that were associated with activity centers within 0.7 miles.

Within the range of the Northern Spotted Owl in California, a total of 175 THPs were submitted to CAL FIRE in 2013 from ten counties (Del Norte, Humboldt, Mendocino, Shasta, Siskiyou, Sonoma, Napa, Marin, Tehama, and Trinity counties). Of these, 115 THPs were associated with owl activity centers, encompassing approximately 69,226 acres of proposed harvest on private timberland. Figures 12 and 13 summarize number and percent of THPs submitted from each county on the interior and coastal regions. Of the 115 THPs, 93 were coastal THPs associated with owl activity centers within 0.7 mile, and 22 were interior THPs associated with owl activity centers within 1.3 miles.

Of the 115 THPs associated with owl activity centers, a total of 66 utilized Option (e) (60 coastal and six interior), and 9 utilized Option (g) (two coastal and seven interior) in 2013. Silvicultural prescription

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methods and associated acres of proposed harvest from the 66 THPs that applied Option (e) in 2013 are summarized in Figure 14. Silvicultural prescription methods and associated acres of proposed harvest from the nine THPs that applied Option (g) in 2013 are summarized in Figure 15. Variable Retention prescription was the most utilized method for THPs using Option (e), with nearly 28,000 acres of proposed harvest. Alternative, Clear Cut, and Shelterwood prescriptions were the most utilized method for THPs using Option (g), with 1,413, 714, and 657 acres of proposed harvest, respectively. The number of THPs and the cumulative proposed acres for THPs utilizing Option (e) far surpassed those using Option (g).

Proposed silvicultural prescription methods and harvest amounts within the interior and coastal THPs varied significantly. The dominant methods and acreages for 2013 interior and coastal THPs that used Option (e) and Option (g) and are associated with activity centers are summarized in Table 12. In the interior, the Alternative method was proposed more than any other method, covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total acreage. When the Alternative method is used, the plan must include a description of which silvicultural method is most nearly appropriate or feasible, and must also describe how the Alternative method differs from the most similar method. For plans using the Alternative method in the interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the Alternative method used. Alternative method units typically include a habitat retention area, which can range from 2-10% of the harvest unit. Habitat retention areas usually include hardwoods and/or cavity trees to promote use by wildlife species. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more area than all other methods combined.

Table 12. Silvicultural prescription methods proposed within 1.3 miles of an activity center in interior THPs and within 0.7 miles of an activity center in coastal THPs in 2013.

<u>13 THPs from</u>		<u>62 THPs from</u>	
<u>Interior Counties</u>	<u>Acres</u>	<u>Coastal Counties</u>	<u>Acres</u>
Alternative	9,798	Variable Retention	28,144
Group Selection	2,389	Selection	5,227
Clear Cut	2,257	Group Selection	4,314
Shelterwood Removal	1,574	Transition	3,470
Commercial Thinning	1,335	Seed Tree Removal	1,645
No Harvest Areas	1,015	Clear Cut	1,404
		Rehabilitation	990

To better understand the level of impact of proposed harvest and retention to owl activity centers, each THP utilizing Option (e) and Option (g) in 2013 within the interior and coastal region was assessed further. For 13 interior THPs (six using Option (e) and seven using Option (g)), habitat retention and harvest were assessed at two scales: within 0.5 miles and between 0.5 and 1.3 miles of an activity center. For 62 coastal THPs (60 using Option (e) and two using Option (g)), habitat retention and harvest was only assessed within 0.7 miles of an activity center.

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2360 It is important to note that the Forest Practice Rules and USFWS guidance regarding habitat retention
2361 vary. As mentioned previously, the Forest Practice Rules outline appropriate retention guidelines to be
2362 established within THPs submitted under Option (g). In 2009, the USFWS made recommendations for
2363 habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat
2364 from Forest Practice Rules guidelines.

2365 Forest Practice Rules guidelines under Option (g) are:

- 2366 • Nesting habitat must be retained within 500 feet of the activity center
- 2367 • Roosting habitat must be retained within 500-1000 feet of the activity center
- 2368 • 500 acres of owl habitat must be provided within 0.7 mile radius of the activity center
- 2369 • 1336 acres of owl habitat must be provided within 1.3 mile radius of the activity center

2370 The USFWS (2009) recommendations are:

- 2371 • No timber removal within 1000 feet of activity center, either inside of outside of the breeding
2372 season
- 2373 • At least 250 acres of nesting/roosting habitat and at least 150 acres of foraging habitat must be
2374 retained within 0.5 mile radius of the activity center
- 2375 • Between 0.5-1.3 mile radius of the activity center at least 655 acres of foraging habitat and 280
2376 acres of low quality foraging habitat must be retained

2377 As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern
2378 Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option
2379 (e) in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2380 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center
2381 once timber harvesting had been completed. For each of the six interior THPs, four primary habitat
2382 types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting
2383 as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option
2384 (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a
2385 given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-
2386 habitat.

2387 Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for
2388 THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior,
2389 and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the
2390 interior (2,117 acres within 0.5 miles and 9,776 acres within 0.5-1.3 miles). On the coast, foraging and
2391 nesting/roosting were retained at relatively similar levels within 0.7 miles (52,817 acres of foraging;
2392 47,344 acres of nesting and roosting).

2393 As noted previously, seven interior THPs and two coastal THPs associated with a total of 14 Northern
2394 Spotted Owl activity centers (8 interior activity centers, and 6 coastal activity centers) utilized Option (g)
2395 in 2013. For interior THPs, a pre- and post-harvest habitat analysis was conducted to determine the
2396 amount of suitable owl habitat that would potentially exist within 0.5 and 1.3 mile of an activity center

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once timber harvesting had been completed. For each of the seven interior THPs, habitat types were assessed: low quality foraging, foraging, and nesting and roosting. For the two coastal THPs that utilized Option (g) a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given THP. For these two THPs, three primary habitat types were assessed: foraging, nesting/roosting, and non-habitat.

2402

Table 13. Proposed acres of habitat retention near activity centers from THPs utilizing Option (e) in 2013. Totals include retention acres for 6 interior THPs and 60 coastal THPs (66 THPs total). Owl habitat is defined as low quality foraging (LQF), foraging (F), nesting/roosting (NR), high quality nesting/roosting (HQNR), and non-habitat (NH).

	<u>6 Interior THPs associated with 14 activity centers, Option (e)</u>		<u>60 Coastal THPs associated with 132 activity centers, Option (e)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	770	4,702	n/a
F	2,117	9,776	52,817
NR	1,487	6,324	47,344
HQNR	1,649	2,940	n/a
NH	n/a	n/a	31,222

2406

Table 14 summarizes proposed acres of owl habitat retention within the interior and coastal regions for THPs utilizing Option (g). Total acreages presented are cumulative acres for 7 THPs within the interior, and 2 THPs within the coast. Within the interior, nesting/roosting and foraging habitat were similarly proposed for retention, with Low Quality Foraging the least common habitat type retained. Within the coast, nesting/roosting habitats were retained more than either foraging or non-habitat.

2412

Table 14. Proposed acres of habitat retention near activity centers from THPs utilizing Option (g) in 2013. Totals include retention acres for 7 interior THPs and 2 coastal THPs (9 THPs total). Owl habitat is defined as low quality foraging (LQF), foraging (F), nesting/roosting (NR), and non-habitat (NH).

	<u>7 Interior THPs associated with 8 activity centers, Option (g)</u>		<u>2 Coastal THPs associated with 6 activity centers, Option (g)</u>
	Acres within 0.5 miles of ACs	Acres between 0.5 to 1.3 miles of ACs	Acres within 0.7 miles of ACs
LQF	612	3,004	n/a
F	1,032	3,171	1,548
NR	1,388	3,879	2,763
NH	n/a	n/a	1,597

2416

Over time, activity centers may be cumulatively impacted by timber management activities. Through the use of Option (e) and Option (g), habitat retention and harvest for interior THPs from 2013 were typically assessed within 0.5 miles and between 0.5 and 1.3 miles of an activity center; whereas for

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coastal THPs from 2013 habitat retention and harvest were assessed primarily within 0.7 miles of an activity center. The 0.5 mile and 0.7 mile radius around activity centers is meant to capture the core habitat use of Spotted Owls within their home range, whereas the 1.3 mile radius is meant to capture the broader home range. Therefore timber harvest within these radii has a potential to impact quality and extent of owl habitat, and consequently, owl fitness. As discussed previously, to mediate this loss the Forest Practice Rules set limits on the amount and type of habitat that may be harvested within certain radii. Since timber growth is slow, and consequently, regrowth of owl habitat is slow, it is important to understand the cumulative impact to activity centers over time.

To consider the risk of habitat removal to individual activity centers, the amount of habitat proposed for harvest was calculated for activity centers addressed in THPs utilizing Option (e) and Option (g) over various periods in time between 1986 and 2013 (Tables 15 and 16). The activity centers evaluated were selected from those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by evaluating all THPs associated with these activity centers in past harvest history. The sample selected for evaluation did not include all of the activity centers associated with THPs in 2013, only a subset. Activity centers were chosen from all counties associated to provide results on a broad scale. An approximately even number of activity centers were chosen from each county. At the proposed levels of harvest noted in the THPs, it is apparent that some activity centers have experienced extensive habitat removal or modification over time. Of the 17 activity centers evaluated in the interior, six activity centers have experienced greater than 2,000 acres timber harvest cumulatively over time within the 1.3 mile radius (~3,400 acres) home range, and six activity centers have experienced greater than 250 acres timber harvest within the 0.5 mile radius (~500 acres) core range. Of the 14 activity centers evaluated on the coast, six activity centers experienced harvest of over 500 acres, cumulatively, within the 0.7 mile radius (~985 acres) core range, with two of these over 1,000 acres. Appendix 3 includes bar graphs for each activity center within the coast and interior provinces/regions?, and depicts level of harvest within 0.5, 0.7, and 1.3 mile radii from the activity center.

Comment [JEH13]: I am not really clear on what Appendix 3 contains, I may have overlooked the explanation.

It is reasonable to assume that high levels of harvest, such as shown for some activity centers in Table 15 and 16, can negatively impact Northern Spotted Owls. Although no study has been conducted specifically linking the amount of harvest within the 0.5, 0.7, and 1.3 mile radius of an activity center to impacts on owl fitness (e.g., reproductive rate, survival, etc.), several research studies have demonstrated a link between owl fitness and amount of habitat, structural characteristics, and spatial configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007). These studies are discussed in more depth above in the Habitat Requirements section (Habitat Effects on Survival and Reproduction) and below in the Habitat Loss and Degradation threat section of this document. Through comparison of Northern Spotted Owl territory loss on private and federal lands, the USFWS (2009) suggests that the Forest Practice Rules have not been entirely effective in preventing cumulative loss of important owl habitat surrounding activity centers associated with repeated harvest. Details regarding the USFWS analysis can be found in the Regulatory Mechanisms Consideration section of this document.

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2458 **Table 15.** Proposed timber harvest (in acres) within interior THPs utilizing Option (e) and Option (g) over time
2459 (range 1997-2013), showing level of harvest within 0.5 miles and between 0.5-1.3 miles of activity centers. The
2460 activity centers evaluated are those that were associated with THPs submitted in 2013; these activity centers were
2461 evaluated over time by evaluating all THPs associated with these activity centers since 1997.

Activity Center	Range of Harvest Years	Interior, Option (e) Acres harvested		Interior, Option (g) Acres harvested	
		0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)	0.5 miles (~500 acre core area)	0.5-1.3 miles (~2,900 acres)
SIS0492	2004-2013	0	915	x	x
SIS0554	1998-2004	102	589	x	x
TEH0030	1998-2013	381	2,554	x	x
TEH0037	1998-2013	379	2,221	x	x
TEH0038	1998-2013	151	1,002	x	x
TEH0072	1998-2013	476	1,954	x	x
TEH0075	1997-2004	277	2,530	x	x
TEH0087	1998-2013	291	2,137	x	x
TEH0101	1997-2013	168	2,113	x	x
TEH0114	2002	0	8	x	x
TEH0117	2006-2013	37	1,123	x	x
SHA0024	2003-2005	x	x	41	239
SHA0037	1998-2013	x	x	0	426
SHA0106	2000-2013	x	x	21	160
SIS0319	1997-2013	x	x	31	1,505
TRI0169	2000-2013	x	x	0	118
TRI0316	1997-2013	x	x	251	495

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2468 **Table 16.** Proposed timber harvest (in acres) within coastal THPs utilizing Option (e) and Option (g) over time
2469 (range 1986-2013), showing level of harvest within 0.7 miles of activity centers. The activity centers evaluated are
2460 those that were associated with THPs submitted in 2013; these activity centers were evaluated over time by
2461 evaluating all THPs associated with these activity centers since 1986.

Activity Center	Range of Harvest Years	Coast, Option (e) Acres harvested within 0.7 mile radius (~985 acre core area)	Coast, Option (g) Acres harvested within 0.7 mile radius (~985 acre core area)
HUM0058	2011-2013	30	x
HUM0400	1990-2013	510	x
HUM0622	1993-2013	798	x
HUM0791	1999-2013	270	x
HUM0986	1997-2013	162	x
MEN0146	1994-2013	1,180	x
MEN0309	1987-2013	565	x
MEN0370	1992-2010	413	x
HUM0097	1996-2013	x	345
HUM0098	2004-2005	x	67
HUM0308	1996-2013	x	226
HUM0442	2004-2013	x	227
MEN0082	1986-2013	x	1,316
MEN0114	1987-2013	x	829

2468
2469

2470 Nonindustrial Timber Management Plans

2473 In 1989, the Legislature added language to the Forest Practice Act creating provisions to include
2472 Nonindustrial Timber Management Plans (NTMPs) to promote long term management and planning on
2473 forest ownerships of 2,500 acres or less (Pub. Resources Code §4593 et seq.). Private forestlands are
2474 generally classified into non-industrial and industrial ownerships based on acreage and association with
2472 industrial uses. Non-industrial private forest (NIPF) owners typically have less than 5,000 acres of
2476 forestland and do not own a mill. Of the private forestlands in California, NIPF owners collectively hold
2477 about 3.2 million acres (41%), with the balance being held by industrial forest landowners.

2477 The NTMP allows smaller NIPF timberland owners to prepare a long-term management plan that
2479 reduces regulatory time and expense by providing an alternative to submitting individual THPs prior to
2480 harvest. Landowners agree to manage their forests through uneven-aged management and long-term
2480 sustained yield, in exchange for a higher degree of regulatory surety. “Sustained yield” means the yield
2481 of commercial wood that an area of commercial timberland can produce continuously at a given
2482 intensity of management consistent with required environmental protection and which is professionally
2484 planned to achieve over time a balance between growth and removal (Pub. Resources Code, § 4593.2,
2483 subd. (d); Forest Practice Rules, § 895.1). Timberland owners operating under an NTMP are also
2486 protected under provisions of Public Resources Code section §4593, which offers landowners exemption

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2487 from applying subsequent rule changes to Forest Practice Rules to their project; however, this does not
2488 mean that a NTMP will never be subject to new laws or regulations.

2489 Public Resources Code section §4594 subdivision (h) requires RPFs to submit a Notice of Operations
2490 (NTO) prior to harvest that specifies that the NTMP will implement best management practices for the
2491 protection of water, soil stability, forest productivity, and wildlife, as required by the current rules of the
2492 Board, or is consistent with the original plan and will not result in any significant degradation to the
2493 beneficial uses of water, soil stability, forest productivity or wildlife. Required applications and
2494 administration of NTMPs are detailed in the Forest Practice Rules commencing with section 1090.
2495 Landowners submitting proposed NTO's subsequent to requirements of Forest Practice Rules, section
2496 919.9 [939.9] subdivisions (a) through (g), are expected to either contain specific measures that fulfill
2497 these requirements or best management practices equivalent to such provisions. These options have
2498 resulted in variable and diverse Northern Spotted Owl protection measures within NTMPs; however,
2499 Options (e) and (g) are the most commonly used options. As stated previously, Option (e) allows
2500 landowners to submit a technical assistance letter to the USFWS for approval. Under Option (g), the
2501 landowner must supply the location of activity centers located within the plan boundary or within 1.3
2502 miles of the boundary.

2503 NTMP prevalence has grown steadily since its inception. Table 17 summarizes the approaches
2504 landowners took to protect comply with Forest Practice Rules in avoiding take of Northern Spotted Owl
2505 through NTMPs over time, including numbers of NTMPs within 1.3 miles of an activity center and the
2506 those NTMPs utilizing Option (e) and Option (g) over 1991-2014 for the interior forests, and 2005-2014
2507 for the coastal forests. A total of 157 NTMPs were evaluated within the range of the Northern Spotted
2508 Owl: 35 from the interior portion of the range that were submitted from 1991-2014, and 122 from the
2509 coastal portion of the range that were submitted from 2005-2014. It should be noted that the majority
2510 of NTMPs on the coast were submitted prior to 2005 (418 NTMPs in 1991-2004 versus 122 NTMPs in
2511 2005-2014). However time did not allow full review of that time period for coastal NTMPs. Of the 157
2512 NTMPs evaluated, 115 are within 1.3 miles an owl activity center. Option (e) and Option (g) were applied
2513 in 114 and 14 NTMPs, respectively.

2514 During 1991 through 2014 35 NTMPs have been approved for landowners in the interior portion of the
2515 Northern Spotted Owl range (Siskiyou, Trinity, Shasta, and Tehama counties), with 10 plans utilizing
2516 Option (e), 10 plans utilizing Option (g) and the remainder using another option. Of the 35 NTMPs, 19
2517 (54%) were associated with at least one Northern Spotted Owl activity center within 1.3 miles of the
2518 plan boundary. The coastal portion of the range (Humboldt, Mendocino, Sonoma, Lake, and Napa
2519 counties) saw substantially more NTMPs within a shorter time frame. From 2005 to 2014, 122 NTMPs
2520 were submitted and approved. Although Del Norte County is part of the owl's range, no NTMPs were
2521 submitted during this time frame. Of the 122 NTMPs evaluated, 96 (78%) were associated with at least
2522 one activity center within 1.3 miles of the plan boundary. Of these, the majority (104 NTMPs) utilized
2523 Option (e) (i.e., USFWS technical assistance letter); therefore, the USFWS has been instrumental in
2524 providing consultation and guidance to NTMPs submitters as it relates to protection measures for
2525 Northern Spotted Owl and their habitat.

Comment [A14]: Note to external reviewers:
We are currently working to get all coastal NTMPs (1991-2014) summarized in the table. This will be included in the next version. In addition, number of ACs associated with the NTMPs will be added for all counties.

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2526 **Table 17.** Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years
2527 2005-2014 for plans in Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	NTMPs in NSO Range	NTMPs within 1.3 miles of NSO	NTMPs that implemented 939.9 (e)	NTMPs that implemented 939.9 (g)	NTMPs that used other options
<i>Interior Counties 1991-2014</i>					
Siskiyou	16	13	6	7	1
Trinity	6	3	2	2	0
Shasta	11	3	2	1	0
Tehama	2	0	0	0	2
Interior Subtotal	35	19	10	10	3
<i>Coastal Counties 2005-2014</i>					
Humboldt	41	40	38	2	0
Mendocino	58	45	43	2	0
Sonoma	19	9	19	0	0
Lake	3	1	3	0	0
Napa	1	1	1	0	0
Coastal Subtotal	122	96	104	4	0
Total	157	115	114	14	3

2528

2529

2530 For NTMPs in Siskiyou, Trinity, and Shasta counties measures were analyzed for proposed silvicultural
2531 prescription methods for years 1991-2014, and for years 2005-2014 in Humboldt, Mendocino, Sonoma,
2532 Lake, and Napa counties (Table 18). Only NTMPs that occurred within 1.3 miles of a Northern Spotted
2533 Owl activity center were included in this analysis; therefore, Tehama NTMPs have been excluded.
2534 Silvicultural prescription methods noted in Table 18 are those most often proposed within the NTMPs
2535 analyzed. Other prescriptions proposed but not included in Table 18 include Road Right of Way,
2536 Sanitation Salvage, Special Treatment, Fuel break, and Variable Retention, and is inclusive of 747
2537 cumulative acres.

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2538 **Table 18.** Acres proposed for harvest under NTMPs within 1.3 miles of a Northern Spotted Owl activity center for
2539 various silvicultural prescriptions. NTMPs are from years 1991-2014 for Siskiyou, Trinity, and Shasta counties, and
2540 2005-2014 for Humboldt, Mendocino, Sonoma, Lake, and Napa counties.

County	Selection	Group Selection	Uneven-aged	Commercial Thinning	Non-Timberland Area	Transition	Rehabilitation of under-stocked
<i>Interior Counties</i> <i>1991-2014</i>							
Siskiyou	2597	60	1127	251	22	251	251
Trinity	2783	237	653	0	0	0	0
Shasta	1609	1036	2276	273	463	0	0
Interior Subtotal	6989	1333	4056	524	485	251	251
<i>Coastal Counties</i> <i>2005-2014</i>							
Humboldt	2322	6139	0	35	424	1101	1658
Mendocino	4561	1926	0	0	419	975	71
Sonoma	547	4603	0	0	127	245	246
Lake	45	587	0	0	0	0	0
Napa	0	683	0	0	17	0	0
Napa-Lake	1858	0	0	0	0	0	0
Coastal Subtotal	9333	13938	0	35	987	2321	1975
Total	16322	15271	4056	559	1472	2572	2226

2541

2542 Of the NTMPs included in this analysis, a total of 42,478 acres were proposed for harvest within 1.3
2543 miles of an activity center. Selection, Group Selection, and Uneven-aged silvicultural methods are the
2544 most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through
2545 the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection,
2546 Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Most plans that
2547 used the Uneven-aged silvicultural method did not delineate acres that would fall under each category.
2548 For NTMPs submitted on the interior from 1991-2014, Selection, Group Selection, and Uneven-aged
2549 totaled 6,989, 1,333, and 4,056 acres, respectively. For NTMP submitted from 2005-2014 on the coast,
2550 Selection and Group Selection totaled 9,333 and 13,938 acres, respectively. Cumulatively, these more
2551 common silvicultural methods equates to 29% (12379/42478) of the total acres proposed for harvest

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2552 under interior NTMPs analyzed, and 55% (23271/42478) of the total acres proposed for harvest under
2553 coastal NTMPs analyzed.

2554 The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl
2555 habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear
2556 that some information was not available to the reviewer due to the nature of the older NTMP
2557 narratives, limited public information, and subsequent amendment submissions. There is simply no
2558 effective way to track this information in an analysis going back in time. Though Selection and Group
2559 Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range,
2560 we can infer that owl habitat is retained to some extent; however, we could not determine the type or
2561 quality of habitat retained. For instance, high quality nesting and roosting habitat may be harvested
2562 more frequently, thereby reducing owl fitness.

2563 Spotted Owl Management Plans

2564
2565 A Spotted Owl Management Plan (SOMP) details measures to avoid take of Northern Spotted Owl as a
2566 result of timber harvest operations on privately owned land. SOMP are developed cooperatively
2567 between USFWS and a private land owner, and can be used to streamline the review of THPs. SOMP
2568 follow the procedures in Forest Practice Rules section 939.9 subdivision (e) and include:

- 2569 • a description of the area covered
2570 • protection measures for breeding or nesting Northern Spotted Owls
2571 • habitat definitions, and
2572 • habitat quality and quantity retention requirements

2573
2574 SOMP are contain expiration dates upon which USFWS and land owners meet to review and revise the
2575 document as necessary; however, incorporation of new scientific information may occur at any time
2576 during the lifetime of the SOMP. SOMP differ from the standard no-take measures provided in the
2577 Forest Practice Rules in that they utilize site-specific information in conjunction with research to develop
2578 strategies to avoid take over a period of years. The most notable difference between SOMP no-take
2579 requirements and those in the standard Forest Practice Rules section is the primarily survey area
2580 required and possibly habitat required post-harvest. Survey areas may be reduced as a result of local
2581 information collected over a number of years. Post-harvest habitat requirements may also be greatly
2582 reduced or increased based on site specific local information.

2583 Three SOMP are currently being used in the THP process in California. Two of these were reviewed for
2584 this assessment by the Department, totaling 175,700 acres in Siskiyou, Trinity and Shasta Counties. The
2585 Department never received a copy of the third SOMP, located in Mendocino County; therefore we are
2586 unable to discuss it here. Both documents reviewed included the elements listed above, and were
2587 developed with the USFWS considering site-specific information for those properties. Within the SOMP
2588 reviewed, suitable habitat definitions were developed specifically for the ownership(s) utilizing the
2589 SOMP. These habitat definitions are developed using information from the property and may be
2590 different from those suitable habitat definitions in survey protocols or other rules or regulations.

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2591 It is not known if the long-term use of SOMP on private lands in California is limiting Northern Spotted
2592 Owl populations, but all operations conducted under a SOMP occur within the known range of Northern
2593 Spotted Owl and usually within suitable owl habitat. More information is needed to fully understand the
2594 effects of SOMP on Northern Spotted Owls.

2595 Spotted Owl Resource Plans

2596

2597 A Spotted Owl Resource Plan (SORP) is intended to offer landowners submitting THPs a programmatic
2598 approach to avoid take of Northern Spotted Owl. SORPs are addressed in Forest Practice Rules section
2599 919.9 subdivision (a), and is defined as, "...an approach to preventing a taking of the northern Spotted
2600 Owl while conducting timber operations [,]" and "...necessarily involves more than one timber harvest
2601 plan." SORPs do not differ significantly from the required habitat retention guidelines found in the
2602 Forest Practice Rules section 919.9 subdivision (g), and mainly provide a programmatic method for
2603 Northern Spotted Owl protection. A description of the area covered, protection measures for breeding
2604 or nesting Northern Spotted Owls, habitat definitions, survey areas and habitat quality and quantity
2605 retention requirements are all provided within a SORP. A SORP may be submitted to CAL FIRE for
2606 preliminary review, and once approved, can be attached to individual THPs submitted by a landowner
2607 under Forest Practice Rules section 919.9 subdivision (a). The THP is reviewed by the Department, but
2608 not necessarily the SORP.

2609 A total of three SORPs have been approved and are being utilized in the THP process in California, and a
2610 fourth SORP is being prepared. The three approved SORPs cover a total of 358,202 acres. All three
2611 SORPs use a combination of no-take language from Forest Practice Rules section 939.9, along with site-
2612 specific information to develop no-take requirements. No specific habitat definitions were developed for
2613 SORPs, and thus, either standard habitat definitions from the Forest Practice Rules or standard habitat
2614 definitions from the USFWS are used within the plans. The site-specific information is used mostly for
2615 protocol survey areas and noise disturbance buffer distances, and is usually developed from historical
2616 survey records and independent noise level studies.

2617 It is not known if the long-term use of SORPs on private lands in California is limiting Northern Spotted
2618 Owl populations, but all operations conducted under a SORP occur within the known range of Northern
2619 Spotted Owl usually are within suitable owl habitat. More information may be needed to fully
2620 understand the effects of SORPs on Northern Spotted Owls.

2621 Habitat Conservation Plans

2622

2623 Under Section 10(a) of the ESA incidental take, defined as take that is incidental to and not the purpose
2624 of the carrying out of an otherwise lawful activity, may be authorized for federally threatened and
2625 endangered species via a Habitat Conservation Plan (HCP). California's Natural Community Conservation
2626 Planning Act of 1991 takes a broader approach than either CESA or ESA. A Natural Community
2627 Conservation Plan (NCCP) identifies and provides for the protection of plants, animals, and their
2628 habitats, while allowing compatible and appropriate economic activity. HCPs and NCCPs are both long-
2629 term landscape level conservation plans that allow harvest of Northern Spotted Owl habitat, which
2630 could result in a specified level of incidental take of owls within the plan area. Generally, these plans

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2631 require historic and occupied Northern Spotted Owl activity centers to be monitored to ensure a healthy
2632 and stable population, suitable foraging, and nesting habitat to be maintained or created, and activities
2633 to be adjusted accordingly using an adaptive management approach.

2634 Five HCPs that include Northern Spotted Owl as a covered species have been issued in California (Table
2635 19). One plan, on Mendocino Redwood Company land, is in the development process and will be a
2636 combination HCP and NCCP. Each of these plans is described in more detail below.

2637 **Table 19.** Current and planned HCPs/NCCPs in California that include Northern Spotted Owl as a covered species.

Plan Title	Location	Date Permit Issued	Term
Green Diamond Resource Company California Timberlands & Northern Spotted Owl HCP	Humboldt, Del Norte, Trinity Counties	09/17/1992	30 years
Regali Estates HCP	Humboldt County	08/30/1995	20 years
Humboldt Redwood Company HCP	Humboldt County	03/01/1999	50 years
Terra Springs LLC HCP	Napa County	03/03/2004	30 years
Fruit Growers Supply Company HCP	Siskiyou, Shasta, and Trinity Counties	11/27/2012*	50 years
Mendocino Redwood Company HCP/NCCP	Mendocino County	No permits issued	80 years

*A recent court decision in April 2015 determined the Fruit Growers Supply Company HCP to be invalid.

2638
2639
2640 *Green Diamond Resource Company Northern Spotted Owl HCP*

2641
2642 Green Diamond Resource Company (GDRC) inherited the existing Northern Spotted Owl HCP when they
2643 acquired Simpson Timber Company (STC 1992). The HCP has a 30-year term, which expires September
2644 17, 2022, and calls for a full review at the end of 10 years of implementation. GDRC owns approximately
2645 383,100 acres of forestland in California within the Northern Spotted Owl range, mostly within Del Norte
2646 and Humboldt counties, with only small portions in Mendocino and Trinity counties, and is located
2647 within the California Coast Province. Of the 383,100 acres, 86% are conifer forests comprising two
2648 dominant species, coastal redwood, and Douglas-fir. Since most of the conifer forests have been
2649 harvested over the last several decades, second-growth makes up all but a small fraction. Residual areas
2650 of old-growth forests (logged in the early 1940s and 1960s) make up less than 3%, and are concentrated
2651 in the more inland portions of GDRC ownership. Forested areas never logged (virgin old-growth) are
2652 scattered throughout the land ownership and consist of 150 acres of redwood and 300 acres of Douglas-
2653 fir, comprising less than 2% of GDRC land. Hardwood forests (oak species, madrone, alder) comprise 8%,
2654 and non-forest (grassland, wetland, rock and river bars) 6%. As of 1991, just prior to issuance of the HCP,
2655 146 ACs were known to occur on GDRC lands. Density of owls was much higher in the southern portions
2656 of land ownership, than the northern portion (1.2 owls/mi² and 0.32 owls/mi², respectively).

2657 During development, the HCP prepared a 30-year age-class forecast model to determine how much
2658 habitat would be available to owls over time, and developed a predictive habitat (nesting mosaic) model
2659 to estimate nesting habitat on the GDRC land ownership. The age-class forecast covered 1991 through
2660 2021, and assumed timber harvest would occur at an annual rate of 3,000-6,000 acres. Results indicated

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2661 that second-growth stands in the 46+ year age-class would more than double, the 31-45 year age-class
2662 would increase by approximately 50,000 acres in first 10 years then return to 1991 levels, and the 8-30
2663 year age-class would generally decrease over time. The nesting mosaic model was designed to
2664 determine the mosaics of habitat types associated with owl activity centers and utilized the 1991 cover
2665 types and age-classes. Results initially indicated 158,477 acres of GDRC land fit the nesting mosaic
2666 profile, with the number of ACs in 2021 would be roughly the same as the 1991 level.

2667 The level of take (via owl displacement and habitat modification) was estimated at 3 pairs per year over
2668 first 10 years through direct habitat modification (habitat removal within owl sites), and 2 owls per year
2669 over first 10 years via indirect displacement (habitat removal in adjacent stands to owl sites).
2670 Conservation measures were developed to avoid or minimize the likelihood of take, and include:

- 2671 • Habitat management and nest site protection. Implementation will protect nest sites during
2672 breeding and fledging periods, maintain foraging, roosting and nesting habitat, and accelerate
2673 growth of replacement stands. Stands to be harvested March through August will be surveyed
2674 for Spotted Owls before entering area, as well as a 1,000 ft buffer around the area planned for
2675 harvest. Just prior to harvest, up to three more surveys will be conducted. Nest trees will be
2676 marked and no timber harvest is to be conducted within a 0.25 mile radius until after young
2677 have fledged or the nest fails, and a 500 ft radius after fledging until the young disperse.
2678 Valuable land resources for Spotted Owls will be retained on the landscape, such as
2679 hardwood/conifer patches, habitat along watercourses, snags, standing live culls, and brush.
- 2680 • Development of a research program. A research program consists of ongoing owl surveys,
2681 banding owls, monitoring reproductive success, identifying important nest site attributes, and
2682 assessing abundance and distribution.
- 2683 • Development of habitat area to be set-aside. Thirty-nine habitat set-asides were identified in
2684 which timber harvest would not occur. The total acreage of these set asides is 13,242.5 acres
2685 and, as of HCP issuance, 39 owl sites. A 0.25 mile or 500 foot buffers are placed around sites to
2686 ensure timber removal or other associated harvest activities adjacent to set-asides to not impact
2687 owl sites within. Set-asides were monitored annually.
- 2688 • Staff training. A program was developed to properly train GDRC employees and contractors to
2689 monitor owls and collect data.

2690
2691 The trigger for any course correction required during the HCP term will be if the reproductive rate falls
2692 below the rate of the Willow Creek Study Area (WCSA) for three consecutive years. The WCSA was a
2693 good comparison at the time due to its proximity to GDRC and its unique long-term Spotted Owl
2694 dataset. Since 1993, comparisons of reproductive rates at GDRC and WCSA show that the study area
2695 with higher annual reproductive rate often shifts between the two areas. There have not been three
2696 consecutive years with statistically significant results showing the reproductive rate at GDRC falling
2697 below that at WCSA (GDRC 2015).

2698 According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was
2699 happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the

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2700 understanding of suitable owl habitat was limited. In 2006, GDRC submitted an application to the
2701 USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was
2702 issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes
2703 the Project, requires the Applicant to comply with terms of the amended BO and its associated
2704 incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified
2705 the Department that the BO was issued and requested that the Department issue a consistency
2706 determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1.
2707 In January 2014, the Department found that BO, its related ITS and ITP, and the HCP were consistent
2708 with CESA and meet the conditions set forth in Fish and Game Code section 2081 for authorizing
2709 incidental take of CESA-listed species (CDFW 2014a).

2710 The Department found that the mitigation measures identified in the amended ITP and HCP will
2711 minimize and fully mitigate the impacts of take and the continued existence of Northern Spotted Owl
2712 will not be compromised. Measures in the amended versions include, but are not limited to:

- 2713 • Maintaining a 20,310 acres “Special Management Area” in Upper Mad River area where Spotted
2714 Owls may not be taken.
- 2715 • Survey for Spotted Owls in each area where timber harvest is planned, and delay harvest of nest
2716 site and primary activity centers in after the breeding season.
- 2717 • Maintain records of surveys and actual take and notify the USFWS events such as direct harm to
2718 owls, catastrophic events that destroy owl sites, shifts in distribution, accidental death, or injury
2719 of owls, and the finding of dead or injured owls.
- 2720 • Continue gathering data on owl behavior and habitat needs, and update GIS database regularly.
- 2721 • Establish 39 set-asides that represent 13, 252 acres in which timber harvest is not allowed.
- 2722 • Retain, where feasible, resources values that would provide future owl habitat.
- 2723 • Comply, where feasible, with “Overall Resource Management” measures specified in the HCP,
2724 including retention of canopy cover, ground cover, habitat along streams, and a variety of tree
2725 sizes and species within WLPZs.
- 2726 • Implement research on habitat overlap and interactions between Spotted Owls and Barred
2727 Owls.
- 2728 • Conduct surveys according to approved Spotted Owl protocol that accounts for occupancy and
2729 Barred Owl presence, and contact the USFWS for direction as appropriate.
- 2730 • Prepare annual report to record actual instances and number of Spotted Owl sites displaced,
2731 level of habitat loss within owl sites, actual and estimated levels of displacement of past year,
2732 estimated levels of displacement for future year, estimate number of owl sites and amount of
2733 owl habitat, pre- and post-harvest estimates of snags and residual trees in THP areas, results of
2734 nest and set-aside monitoring, and assess efficacy of measures to date.
- 2735 • Provide Department with letter to document financial assurances for HCP implementation.
- 2736

2737 The last annual report (GDRC 2015) described survey results for September 2013 through August 2014
2738 and met the reporting requirements noted above. Since 1992, there has been an overall increase in the

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total amount of Northern Spotted Owl habitat, indicating that growth of forest stands into owl habitat surpassed forested stands impacted by timber harvest. The primary form of incidental take anticipated in the HCP is the displacement of owls due to modification of owl habitat. It was recognized that such displacement could impair essential behavioral patterns and result in actual death or injury to owls. Rather than examining the circumstances of each case to determine whether a take as defined in the ESA had in fact resulted from Green Diamond's habitat modification, the implementation agreement calls for reporting as a "displacement" any instance where an owl site itself is harvested or habitat around an owl site is reduced below thresholds established in the HCP. Each displacement is originally reported on the basis of harvest activity in relation to an owl site within a particular home range; however owls that were recorded as displaced can be removed from the cumulative total if minimum occupancy and nesting criteria are met in the years post-harvest. Based on displacement removal criteria, 33 owls that were recorded as displacements (based on harvest activity) have been removed from the cumulative total (i.e., they are not considered displaced under terms of the HCP). Green Diamond's incidental take permit allows 58 owl pairs to be taken during the 30 year term of the HCP. Although the number of reported displacements per year has been variable, the average is approximately three owl sites per year, leading to 47 owls displaced since 1993 (GDRC 2015).

Regali Estates HCP

This HCP covers 480 acres in Humboldt County, southeast of the town of Ferndale, and is located within the California Coast Province (Regali Estate 1995). Its 20-year term ~~expires~~expired August 30, 2015. The plan covered two Northern Spotted Owl activity centers, and contains white-fir, Sitka spruce, redwood, young tree plantations, grassland, and agriculture. The harvest of conifer species resulted in the immediate loss of nesting habitat for one pair. Due to its small size, take afforded by the plan was not deemed to impact regional Spotted Owl populations. Measures set for the plan included: (1) Retention of habitat around nest sites; (2) No harvest impact for a portion of the covered area; (3) Retention of foraging habitat in harvested areas; (4) Salvage of only commercially valuable dead and dying trees; (5) Planting of conifer trees in open grassland habitat; (6) Retention of slash piles for prey habitat; (7) Monitoring of owls; and (8) Completion of biannual reports.

Humboldt Redwood Company HCP

The HRC HCP covers 211,700 acres of coast redwood and Douglas-fir forest in Humboldt County, and is located within the California Coast Province (HRC 2014). Currently the Plan Area contains approximately 208 Northern Spotted Owl activity centers. The term is 50 years, which means the plan will expire March 1, 2049. The primary covered activity is timber management (timber harvest and regeneration, site preparation, planting, vegetation management, thinning, and fire suppression) occurring on approximately 203,000 acres. The HCP requires ongoing monitoring and reporting to ensure that the conservation measures being implemented are accomplishing the desired outcomes. Through the adaptive management process, the monitoring results were used to develop an updated HCP on March 31, 2014.

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2776 The overall strategy in the Northern Spotted Owl conservation plan, detailed in the HCP, is to (1)
2777 minimize disturbance to Northern Spotted Owl activity sites, (2) monitor to determine whether these
2778 efforts maintain a high-density and productive population of owls on the ownership, and (3) apply
2779 adaptive management techniques when new information on owl biology/ecology is available and to best
2780 assess the performance of management objectives. Specific habitat retention requirements are
2781 provided to conserve habitat for nesting, roosting, and foraging owls.

2782 Northern Spotted Owl management objective outlined in the plan include:

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1. Maintain a minimum of 108 activity centers each year over the life of the HCP.
2. Maintain Northern Spotted Owl pairs on an average of 80 percent (over a five-year period) of the minimum 108 activity centers on the ownership. At least 80 of these sites shall be “Level One” sites, and the balance shall be “Level Two” sites.
3. Maintain an average reproductive rate of at least 0.61 fledged young per pair (over a five-year period) for the minimum of 108 activity centers on the ownership.
4. During the first five years of the HCP, maintain and document the minimum number of activity centers designated in the HCP.

2792 Northern Spotted Owl conservation measures outlined in the plan include:

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1. Establish a Northern Spotted Owl Scientific Review Panel to review and make recommendations for monitoring techniques, offer expert review of monitoring results, and make recommendations on habitat retention standards for maintenance and recruitment of activity centers.

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2. Conduct a complete annual censuses (or and approved sampling methodology) to monitor all activity centers on the ownership and to determine numbers of pairs, nesting pairs, and reproductive rates.

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3. If activities are initiated before February 21 and are maintained continuously past the onset of the breeding season (March 1 through August 31) the THP and a 1,000 foot buffer is to be surveyed, with timing and number of surveys dependent on when activities are to occur within the breeding season. For site preparation activities initiated between March 1 and May 31 site visits will be conducted based on known activity centers within 1,000 feet of activity. Details on how and when site visits are to occur are site specific. No surveys required if timber operations occur only outside the breeding season.

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4. Before June 1 each year, at least 80 activity sites shall be maintained using the habitat retention guidelines detailed in the HCP, referred to as “Level One” habitat retention. Activity sites selected for “Level One” retention must have supported owls in the previous year and must also be active for the year in which the site is selected. If a site is determined to be nesting, no harvesting shall occur during the breeding season within a 1,000-foot radius of the nest tree.

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- 2813 Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the
2814 activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting
2815 habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable
2816 owl habitat must be provided, if present, and less than 50 percent of this shall be under
2817 operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided,
2818 within 1.3 miles of each activity center.
- 2819 5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of
2820 each year to make up the minimum number of activity centers designated by the HCP. “Level
2821 Two” habitat retention must be active for the year in which the site is selected. If a site is
2822 determined to be nesting, no harvesting shall occur during the breeding season within a 1,000-
2823 foot radius of the nest tree. Following the breeding season, 18 acres around the AC shall be
2824 maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC
2825 must be in place. For sites, which have been determined to be occupied by a non-nesting pair
2826 or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if
2827 present, and a 400 foot radius buffer protecting the activity center must be in place. Harvesting
2828 of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat
2829 retention area.
- 2830 6. Activity center that are not needed to meet management objectives above shall receive “Level
2831 Three” protection measures. These activity centers shall have a 1,000-foot buffer during the
2832 breeding season. Timber harvest associated may occur before March 1 or after August 31.
2833 During the breeding season, for activity centers which have been determined to be occupied by
2834 a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as
2835 suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur
2836 during the breeding season in the area adjoining the 18-acre habitat retention area.
- 2837 7. All nest trees shall be marked and be retained if the activity center is harvested.
- 2838 The HCP outlines an objective to conserve habitat diversity and structural components within the plan
2839 area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types
2840 and seral stages are maintained across the landscape over the permit period, as well as structural
2841 components, to contribute to the maintenance of wildlife species covered under the plan, including the
2842 Northern Spotted Owl.
- 2843 Structural components to be retained include:
- 2844 1. A certain number and size snags that do not pose a human safety hazard.
- 2845 2. A certain number and size of green replacement trees, if snags are not present, with a priority
2846 for trees other than redwood.

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- 2847 3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority
2848 given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or
2849 cavities.
- 2850 4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a
2851 maximum of two per acre.
- 2852 5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given
2853 to logs over 30 inches in diameter.
- 2854 In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that
2855 the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section
2856 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in
2857 fact consistent with CESA and meet the conditions set forth in Fish and Game Code section 2081 for
2858 authorizing incidental take of CESA-listed species (CDFW 2014b).
- 2859 The Department found that the mitigation measures identified in the amended ITP and HCP will
2860 minimize, will fully mitigate the impacts of take and will not compromise the continued existence of
2861 Northern Spotted Owl. Measures in the amended versions include, but are not limited to:
- 2862 • Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and
2863 federal governments to ensure their functions as wildlife reserves in perpetuity.
 - 2864 • Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting
2865 habitat in a series of Marbled Murrelet Conservation Areas (MMCAs).
 - 2866 • Conduct a combination of night and daytime surveys and stand searches to locate both known,
2867 and any new, owl activity centers.
 - 2868 • Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other
2869 conservation elements of the HCP for the retention and recruitment of potential foraging,
2870 roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
 - 2871 • Maintain a minimum of 108 activity centers each year over the life of the HCP.
 - 2872 • Maintain an average reproductive rate of at least 0.61 fledged young per pair, over a five-year
2873 period, for the minimum of 108 activity centers on the ownership.
 - 2874 • Conduct complete annual censuses to monitor all activity centers on the ownership and to
2875 determine numbers of pairs, nesting pairs, and reproductive rates.
 - 2876 • Survey the THP area and a 1,000-foot buffer for new operations, except site preparation,
2877 initiated in the period beginning February 21 and ending on or before August 31.
 - 2878 • Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and
2879 detection probabilities using accumulated survey data.
 - 2880 • Submit annual reports describing the activities undertaken, results of the Operating
2881 Conservation Program, and the proposed Operating Conservation Program activities for the next
2882 year for all lands covered by the HCP.
 - 2883

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2884 Annual reports for Northern Spotted Owl have been developed since the HCP's inception. The most
2885 current report (HRC 2015) summarizes the Humboldt Redwood Company's survey effort and whether
2886 management objectives were met. The report states,

2887 "Management objective 1 of the HCP, which requires the maintenance of a minimum of 108
2888 activity sites in the HCP area, was met in 2014 with 136 total occupied activity sites including the
2889 108 core sites. There are currently 215 total activity sites (occupied and unoccupied) on the
2890 property. Management objective 2, which calls for maintenance of Spotted Owl pairs on a five
2891 year running average of 80% at core activity sites, was met in 2014 with a running average of
2892 82%. The pair occupancy rate for 2013 was also 84% (91 of the 108 cores sites were occupied by
2893 a pair of Spotted Owls). Management objective 3 requires the maintenance of a five-year
2894 running average reproductive rate of at least 0.61 fledged young per pair for the core sites (for
2895 those pairs monitored to determine reproductive output). Nesting activity was verified for 33 of
2896 the 91 pairs (of the 108 core sites), and a total of 45 young were fledged, resulting in a
2897 reproductive rate of 0.49 in 2014. The five-year running average of the reproductive rate for the
2898 fifteenth year of the HCP is 0.42, below the requirements of management objective 3."

2899 *Mendocino Redwood Company HCP/NCCP (in planning process; not issued)*

2900 The Mendocino Redwood Company (MRC) is in the process of developing a HCP and NCCP with the
2901 federal and state agencies. ~~Once~~ If the permit is issued, the term ~~will~~ would be 80 years. The HCP/NCCP
2902 will determine how MRC manages threatened and endangered species, rare plants, and natural
2903 communities on their land ownership in Mendocino ~~and Sonoma~~ counties. The Northern Spotted Owl
2904 will be a covered species in the plan. Coverage is proposed for 203,940 acres of a Approximately 228,800
2905 acres of coast redwood and Douglas-fir forests exist on that comprise the total MRC land ownership,
2906 which ~~and~~ is located within the California Coast Province. Up to date progress on the HCP/NCCP
2907 development can be found on the MRC website (<http://www.mrc.com>).

2908 *Terra Springs LLC HCP*

2909 The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the
2910 Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa
2911 County west of the city of St. Helena, and is located within the California Coast Province. The plan has a
2912 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year
2913 old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered
2914 lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the
2915 covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded
2916 by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to
2917 maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while
2918 accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting,
2919 roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their
2920 management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees,
2921 felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices,

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2923 retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous
2924 snags, retention of down logs; (3) Timber operations to cease within a 1000 ft buffer of the owl activity
2925 center during the breeding season; (4) Monitor the Spotted Owl site for five years subsequent to the
2926 timberland conversion; and (5) Annual reporting for the first 5 years of the permit.

2927 *Fruit Growers Supply Company HCP*

2928
2929 The Fruit Growers Supply Company (FGS) HCP covers commercial timberland owned and managed by
2930 FGS in Siskiyou County, totaling 152,178 acres (FGS 2012). The Plan Area is within the California Klamath
2931 Province and California Cascades Province. The HCP has a 50 year term that expires November 27, 2062.
2932 In February 2014, FGS notified the Department that the federal BO was issued and requested that the
2933 Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1.
2934 In March 2014, after an amendment to the HCP to fully meet mitigation standards, the Department
2935 found that BO and its related ITS and ITP, and the HCP were consistent with CESA and meet the
2936 conditions set forth in Fish and Game Code section 2081 for authorizing incidental take of CESA-listed
2937 species (CDFW 2014c).

2938 In April 2015, the United States District Court, Northern District of California, found FGS's HCP to be
2939 invalid for the incidental take of two threatened species, the Northern Spotted Owl and the Southern
2940 Oregon/Northern California Coast Coho Salmon. The Order on Cross-Motions for Summary Judgment in
2941 the case *Klamath-Siskiyou Wildlands Center, Center for Biological Diversity, and Klamath Forest Alliance*
2942 *vs. National Oceanic and Atmospheric Administration, National Marine Fisheries, and the United States*
2943 *Fish and Wildlife Service, and Fruit Growers Supply Company* states, "For the reasons explained below,
2944 the Court ... finds the incidental take permits issued by the Services, the biological opinion issued by
2945 NMFS, and the Final Environmental Impact Statement invalid." The HCP amendment to fully meet
2946 mitigation standards was not considered in this case.

2947 Timber management was the primary activity affecting approximately 150,000 acres. FGS land consists
2948 of three management units: Klamath River covering 65,340 acres, Scott Valley covering 39,153 acres,
2949 and Grass Lake covering 47,685 acres. Klamath River and Scott Valley units are dominated by second-
2950 growth mixed evergreen forests that include Douglas-fir, incense-cedar, white fir, ponderosa pine, sugar
2951 pine, canyon live oak, Pacific madrone, California black oak, and Oregon white oak. The Grass Lake unit
2952 contains three major forest types: Sierran Montane Forest and Upper Montane Forest at higher
2953 elevations and Northern Yellow Pine Forest at lower elevations. The Northern Yellow Pine is most
2954 common in the Grass Lake unit, and is dominated by ponderosa pine and white fir. The hardwood
2955 understory species (e.g., oak species and madrone) are largely absent in this unit. Because most of FGS
2956 land has been in commercial timber production since the early 1900s, forests are relatively young (less
2957 than 80 years old) with only small, isolated patches of older stands. Less than 1 percent of the forested
2958 area in the three management units are in WHR size class 5 (> 24 inches dbh) and are considered late-
2959 seral stage. Most of the forested lands (79-93%) are in WHR size classes 3 and 4 (6-24 inches dbh) and
2960 are considered mid-seral.

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2961 Covered Activities had the potential to alter forest characteristics, and influence the availability and
2962 quality of habitat for Northern Spotted Owls. Northern Spotted Owl surveys on FGS lands and adjoining
2963 federal and private lands have shown that many activity centers are located on or have a home range
2964 that extends onto the FGS ownership.

2965 Safe Harbor Agreements

2966
2967 The USFWS states (<http://www.fws.gov/endangered/landowners/safe-harbor-agreements.html>):

2968 “A Safe Harbor Agreement (SHA) is a voluntary agreement involving private or other non-
2969 Federal property owners whose actions contribute to the recovery of species listed as
2970 threatened or endangered under the ESA [see section 10(a)(1)(A)]... In exchange for actions that
2971 contribute to the recovery of listed species on non- Federal lands, participating property owners
2972 receive formal assurances from the Service that if they fulfill the conditions of the SHA, the
2973 Service will not require any additional or different management activities by the participants
2974 without their consent. In addition, at the end of the agreement period, participants may return
2975 the enrolled property to the baseline conditions that existed at the beginning of the SHA.”

2976 There are two SHAs covering Northern Spotted Owl in California, Forster-Gill, Inc., and The Fred M. van
2977 Eck Forest Foundation.

2978
2979 *Forster-Gill, Inc., Safe Harbor Agreement*

2980
2981 The Forster-Gill SHA was issued in June 2002 has a 90-year term, and consists of 236 acres in Humboldt
2982 County one mile north of the town of Blue Lake (USFWS 2002). The majority of the property (91%)
2983 contains young growth coastal redwood (30-35 years old), with 216 acres containing WHR type 4D (12-
2984 24 inch dbh and 60-100 percent canopy closure). At the time of the SHA issuance two owl activity
2985 centers were adjacent to the property, both associated with one pair.

2986 In the SHA, Forster-Gill agrees to enhance and maintain approximately 216 acres of forested Northern
2987 Spotted Owl habitat through timber harvest management designed to create uneven-aged stands with
2988 large tree components, characteristic of high quality owl habitat. Specifically, the SHA will:

- 2989
- 2990 • Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
 - 2991 • Retain all snags not posing a hazard risk.
 - 2992 • Conduct annual owl surveys on property and within a 500 foot radius around the property.
 - 2993 • Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
 - 2994 • Ensure no harvest occurs within 1,000 ft of any active owls nest site.
 - 2995 • Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single
2996 tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and
2997 approved by USFWS.
 - Conduct timber stand inventories and provide USFWS with data.

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- 2998 • Allow USFWS or other agreed-upon party access to property for monitoring and management
2999 activities.

3000
3001 *The Fred M. van Eck Forest Foundation Safe Harbor Agreement*
3002

3003 The van Eck Foundation SHA was issued in August 2008 has a 90-year term, and covers management
3004 activities on 2,163 acres of land in Humboldt County owned by The Fred M. van Eck Forest Foundation
3005 (USFWS 2008a). Four management units are identified, of which three (Lindsay Creek, Squaw Creek and
3006 Fieldbrook) are located in the Lindsay Creek watershed about one mile of the town of Fieldbrook. The
3007 fourth unit, Moonstone, is located in the about ½ mile east of the community of Westhaven. The main
3008 forest types found include redwood, Douglas-fir, grand fir, western hemlock, and Sitka spruce.
3009 Approximately 80% of the land contains nesting and roosting habitat, with dense canopy cover, and
3010 trees over 16 inch dbh. At the time of SHA issuance, no Spotted Owl nesting was documented, however
3011 a roosting single and pairs were located on Lindsay Creek.

3012 The SHA incorporates the terms of the conservation easement granted to Pacific Forest Trust (PFT) in
3013 2001. The conservation easement includes performance goals and restrictions that create forest
3014 component recognized as high quality owl habitat. The lands enrolled in this SHA are also currently
3015 managed under a NTMP.

3016 In the SHA, van Eck Foundation agrees to ~~maintain and protect 6.5 acres of nesting and roosting habitat~~
3017 ~~surrounding an AC, and limit harvesting to single-tree selection or group selection with a target of~~
3018 ~~retaining native species and trees that grow vigorously, and nesting/roosting habitat will be expanded~~
3019 ~~and maintained to 1,947 acres (90% of area) for the remainder of the permit term.~~ Exceptions will be
3020 made for trees that have been identified for snag or wildlife tree retention. Canopy cover will remain
3021 above 80% (averaged across the stand) upon completion of harvesting activities. Specifically, the SHA
3022 will:

- 3023 • Comply with the conservation strategy, including management performance goals, restrictions
3024 on harvest, and road construction and maintenance conditions.
- 3025 • Retention of all snags not posing a safety hazard.
- 3026 • Conduct protocol-level surveys and determine reproductive status on property and within 500
3027 foot radius off property, with annual surveys at Lindsay Creek, Squaw Creek, and Fieldbrook
3028 units, and one year prior to harvesting activities at Moonstone unit.
- 3029 • Implement the following protection measures for up to five activity centers, any additional
3030 activity centers on covered lands may be managed in a manner that results in take. A 300 foot
3031 no harvest buffer will be maintained around no more than two activity centers, and a 100 foot
3032 no harvest buffer and a 100 to 300 foot partial harvest buffer will be maintained around no
3033 more than three activities. The activity center currently existing at van Eck and one additional
3034 future activity center will receive the 300 foot no harvest buffer (6.5 acres) around their activity
3035 centers.
- 3036 • ~~Conduct following protection measures: maintain a 300 foot no harvest buffer on up to two~~
3037 ~~activity centers, maintain a 100 foot limited harvest buffer on up to three activity centers, no~~No

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3038 harvest operations to occur within 1,000 feet of any activity center during the breeding season,
3039 and no harvest of any known owl nest trees.
3040 • Cooperate with USFWS on Barred Owl control measures.
3041 • Submit timber inventory reports according to management units
3042 • Allow the USFWS or other agreed-upon party, access to property.
3043 • Conduct annual protocol-level surveys and determine reproductive status and success at owl
3044 nest sites found for a minimum of three years post-harvest.

3045
3046 Exemption Harvest

3047
3048 Exemption harvest is meant to assist private landowners wanting/needing to remove trees and may
3049 allow the removal to be exempt from the THP process. The different types of exemptions available
3050 include:

- 3051 • Forest Fire Prevention Exemption
- 3052 • Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption
- 3053 • Less Than Three Acre Conversion Exemption
- 3054 • Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption
- 3055 • Public Agency, Public and Private Utility Right of Way Exemption
- 3056 • Woody Debris and Slash Removal Exemption
- 3057 • Removal of Fire Hazard Tree within 150 feet of a Structure Exemption
- 3058 • Drought Mortality Amendment Exemption 2015
- 3059 • Protection of Habitable Structures Exemption 2015

3060
3061 Any of the above mentioned exemptions may impact Northern Spotted Owls either directly through
3062 habitat removal or indirectly through noise or visual disturbance, depending on the location and on the
3063 yearly timing of operations

3064 Exemption harvest operations must comply with all aspects of the Forest Practice Rules and various
3065 restrictions regarding the operations under the various emergency conditions. In exemption harvest
3066 actions, no known sites of rare, threatened or endangered plants or animals are to be disturbed,
3067 threatened or damaged. However, Northern Spotted Owl protocol-level surveys and habitat
3068 assessments are not generally required by the Forest Practice Rules to operate under an exemption.

3069 Not all exemptions require an RPF certification. Those that do not require the certification are:
3070 Christmas Tree, Dead, Dying or Diseased Fuel wood or Split Products Exemption, the Public Agency,
3071 Public and Private Utility Right of Way Exemption, Drought Mortality Amendment Exemption and the
3072 Removal of Fire Hazard Trees within 150 feet of a Structure Exemption.

3073 The Christmas Tree/Dead, Dying or Diseased Fuel wood or Split Products Exemption has been available
3074 during the entire time period in which the Northern Spotted Owl has been listed as threatened by the
3075 USFWS. Tree removal is limited to less than 10 percent of the average volume per acre and can be
3076 applied to an entire ownership on any size.

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3077 The Forest Fire Prevention Exemption allows the harvest of green merchantable trees, but the logging
3078 area is limited to 300 acres in size and a statement of the postharvest stand stocking level is required as
3079 required in 1038(i) in the Forest Practice Rules.

3080 The Less Than Three Acre Conversion Exemption is applicable to a conversion of timberland to a non-
3081 timber use only, of less than 3 acres in one contiguous ownership, whether or not it is a portion of a
3082 larger land parcel and shall be not part of a THP. Within one month of the completion of timber
3083 operations, including slash disposal, the timberland owner shall submit a work completion report to CAL
3084 FIRE.

3085 The Substantially Damaged Timberland, Unmerchantable as Sawlog Exemption is not limited to 10% of
3086 the volume per acre and the landowner must notify CAL FIRE of the completion of timber operations
3087 within 30 days of their cessation.

3088 The Public Agency, Public and Private Utility Right of Way Exemption , working with Public Resources
3089 Code section 4628 and Forest Practice Rules section 1104.1(b) exempts public agencies from the
3090 requirement to file an application for timberland conversion or a THP when they construct or maintain
3091 rights of way on their own property or that of another public agency. This exemption extends to
3092 easements over lands owned in fee by private parties. This exemption is not available for rights of way
3093 granted from one private landowner to another.

3094 The Woody Debris and Slash Removal Exemption allows the removal of woody debris and slash that is:
3095 (1) located outside the WLPZ, (2) within the reach of loading equipment operating on existing roads and
3096 landings, (3) developed during timber operations, (4) delivered as combustion fuel for the production on
3097 energy, and (5) in compliance with the conditions of Forest Practice Rules section 1038 subdivision (b)
3098 paragraphs (3),(4),(6),(7),(8) and (10).

3099 The Removal of Fire Hazard Trees within 150 feet of a Structure Exemption allows only trees within 150
3100 feet of an approved and legally permitted structure that complies with the California Building Code
3101 (includes only structures designed for human occupancy, garages, barns, stables and structures used to
3102 enclose fuel tanks) may be harvested under this Notice of Exemption.

3103 The Drought Mortality Exemption was adopted in 2015 by the Board of Forestry due to the prolonged
3104 drought and supercedes the provisions of any other exemption in the same harvest footprint (harvesting
3105 of dead and dying trees). Trees that are dead or trees with fifty percent or more of foliage-bearing
3106 crown that is dead or fading in color are eligible for removal. Under this exemption, it is required to
3107 retain an average for the harvest area of not less than one decadent and deformed tree of value to
3108 wildlife, snag or dying tree per acre that is greater than sixteen inches diameter breast height and
3109 twenty feet tall. This provision does not apply within 100 feet of habitable structures, roads, fire
3110 suppression ridges and infrastructure facilities such as transmission lines and towers or water
3111 conveyance and storage facilities. This exemption requires an RPF signature when timber operations on
3112 a cumulative harvest area exceed twenty acres per total ownership.

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3113 The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to
3114 the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet
3115 from any point of an habitable structure that complies with California Building Code for the purpose of
3116 reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily
3117 comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the
3118 treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2,
3119 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project
3120 area shall be increased in the post-harvest stand.

3121 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3122 approximately 41,767,250 acres (1992 to 2013) have been exempted for harvest in counties within the
3123 range of Northern Spotted Owl (CAL FIRE 2014). These acres do not represent operational acres (actual
3124 acres harvested) but only notification acres (possible intended acres harvested). Operational acre
3125 reporting is not required; therefore there is no data representing the precise amounts or locations of
3126 areas harvested under an exemption. Some of these acres are most likely outside the known range of
3127 the Northern Spotted Owl. In addition, some landowners prepare notifications for their entire
3128 ownership yearly; yet may only operate on only a small area, thereby possibly compounding this
3129 acreage total.

3130 Volume of timber removed under an exemption is reported to the Board of Equalization (BOE), and is
3131 another way to assess levels of exemption harvest. With the precise location and yearly timing of the
3132 volume reported unknown, specific impact assessments cannot be developed. However, the total
3133 volume harvested, average volume amounts by each county and total percentage of harvest volume
3134 may be enough to determine that more information is needed. Yearly exemption harvest volume from
3135 the counties within the known Northern Spotted Owl range date back to 1990 and average
3136 approximately 49,456 MBF (1,000 board-foot) and represent approximately 4.87% of total volume
3137 harvested. The highest total amount harvested occurred in 1994 totaling 164,232 MBF, accounting for
3138 15% of the total volume harvested that year. The total exemption volume harvested during the time
3139 that Northern Spotted Owl has been listed as threatened by the USFWS is 1,186,954 MBF. The largest
3140 amount of exemption volume recorded is from Shasta in 1994 totaling 79,993 MBF, with the largest
3141 percentage of total volume coming from Napa (1994), Marin (1996), Glenn (2003), and Lake (2005),
3142 where 100% of the total volume harvested was exemption volume (BOE 2014). These volume amounts
3143 do not include all volume as the BOE reporting requirements only require volume reporting when
3144 \$3000.00 is obtained. The BOE does not track the volume that is less than \$3000.00 in value (A.
3145 Tenneson, personal communication, November 18, 2015).

3146 It is not known if the long-term exemption harvesting on private lands in California is limiting Northern
3147 Spotted Owl populations, but exemption harvesting may reduce well defined/ critical habitat elements
3148 over time. The current exemption harvest process does not require owl habitat analysis or surveys and
3149 may directly impact Northern Spotted Owl, and therefore more information is needed to fully assess the
3150 impacts from exemption harvest.

3151 Emergency Harvest

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3152
3153 Private landowners may cut or remove timber under an emergency basis if “emergency conditions” exist
3154 pursuant to Forest Practice Rules section 895.1. Emergency conditions are defined as, “... those
3155 conditions that will cause waste or loss of timber resources to the timber owner that may be minimized
3156 by immediate harvesting of infected, infested or damaged timber or salvaging down timber; or those
3157 conditions that will cause appreciable financial loss to the timber owner that may be minimized by
3158 immediate harvesting of timber.”

3159 Types of emergency conditions include:

- 3160 • Dead or dying trees as a result of insects, disease, parasites, or animal damage.
- 3161 • Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood,
3162 landslide, or earthquake.
- 3163 • Dead or dying trees as a result of air or water pollution.
- 3164 • Cutting or removing trees required for emergency construction or repair of roads.
- 3165 • Cutting and removal of hazardous fuels.
- 3166 • Treatments to eradicate an infestation of Sudden Oak Death.

3167
3168 There is some overlap with types of emergency conditions between Exemption and Emergency harvests.
3169 Exemption Harvest allows only 10% of volume of “dead and dying trees” to be removed, while under an
3170 Emergency Harvest the minimum stocking standards need to be met and does not allow the harvest of
3171 merchantable sawlogs. In addition, Emergency Harvests allow removal of dead trees or trees instituting
3172 an obvious large scale economic loss, whereas Exemption Harvest does not.

3173 Emergency Harvest operations must comply with all aspects of the Forest Practice Rules specific to
3174 emergency operations (Forest Practice Rules § 1052 subd. (a)). Before cutting or removing timber on an
3175 emergency basis, an RPF on behalf of a timber owner or operator must submit a Notice of Emergency
3176 Timber Operations. In Emergency Harvest, no known sites of rare, threatened or endangered plants or
3177 animals are to be disturbed, threatened or damaged. However, Northern Spotted Owl protocol-level
3178 surveys and habitat assessments are not generally required to operate during emergency conditions.

3179 During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS,
3180 between 1992 and 2013 approximately 344,542 acres (CAL FIRE 2014) have been notified for emergency
3181 harvest in counties within the owl’s range. These acres may not represent operational acres (actual
3182 acres harvested) but only notification acres (intended acres harvested). Depending on the emergency
3183 condition and stocking requirement, operational acre reporting may not be required; therefore there is
3184 no acreage data or mapping data representing the precise amounts or locations for all emergency
3185 operational areas.

3186 Emergency harvest operations mostly occur in areas where forest stand conditions are dead or fallen,
3187 forest habitat conditions not meeting the definitions of suitable habitat for Northern Spotted Owl under
3188 the Forest Practice Rules, however indirect impacts may occur as a result of the emergency operation.
3189 The emergency notification data is compiled yearly by county, therefore Northern Spotted Owl range-

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3190 specific data is not available. Of the total notification acres between 1992 and 2013, some are most
3191 likely outside the known range of the Northern Spotted Owl as the known range line does not include all
3192 of the county area within this acreage data set.

3193 It is not known if the long-term emergency harvesting on private lands in California is limiting Northern
3194 Spotted Owl populations, however, there is some evidence that salvage logging effects use of burned
3195 areas by Spotted Owls. See the discussion of wildfire in the Threats section for additional discussion on
3196 this type of emergency harvest. Some indirect impacts, such as noise disturbance, may be occurring as a
3197 result of emergency operations but level and extent of this potential impact is not well documented.
3198 More information is needed to fully assess the impacts to Northern Spotted Owl from emergency
3199 harvesting.

3200 Other Management Actions

3201 3202 *Forest Certification Programs*

3203
3204 Some private landowners in California have voluntarily worked with organizations to achieve
3205 certification for their forest landholdings and forestry practices. There are numerous organizations that
3206 certify forest products, with Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI)
3207 being two of the largest. In order for a landowner to attain certification, they must achieve certain
3208 conservation requirements and initiate specific management activities to meet these requirements. For
3209 example, a landowner may be required to increase retention in even-aged units, and to achieve this 10-
3210 30% of the pre-harvest basal area might be retained in a clumped or dispersed fashion. Another
3211 example that could benefit Northern Spotted Owl would be protection of old-growth and legacy trees
3212 through the creation of policy and planning documents that ensure their identification and protection
3213 (T. Bolton, personal communication, September 5, 2014).

3214 The FSC conducts audits to ensure compliance with FSC certification. In addition, the FSC certification
3215 has geographic-specific indicators for the US and Pacific Coast region (FSC 2010a, S. Chinnici, personal
3216 communication, September 3, 2014) and has developed a draft framework for assessing “High
3217 Conservation Value Forests” (HCVFs) to help land managers identify lands with high conservation value
3218 (FSC 2010b). Lands determined to be of high conservation value have extra requirements for
3219 monitoring. Conserving these lands enables landowners to get credit for conservation while being able
3220 to manage other parts of their land for timber products (FSC 2010a).

3221 The Department does not have an accounting of the number of acres of timberland covered by a forest
3222 certification program, nor the quality of the management activities required to meet certification.
3223 Therefore, there is not enough information available to suggest what kind of impact, if any, forest
3224 certification has had on Northern Spotted Owl populations. However, certification programs may have a
3225 positive effect on Northern Spotted Owl in cases where more foraging, nesting, or roosting habitat is
3226 maintained than that called for in the Forest Practice Rules.

3227 *Conservation Easements*

3228

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3229 Most of the conservation easements in forested environments within the Northern Spotted Owl range
3230 allow for some sort of timber harvest. The Department is involved in only a portion of easement/title
3231 projects, and of these projects, the Department is typically not a landowner, title-holder, or manager of
3232 these lands. While working with landowners and managers on the easement/title conditions, the
3233 Department Lands Program staff suggests conditions conducive to the protection and conservation of
3234 wildlife and their habitats.

3235 Due to the variability of landowner needs, the conditions agreed upon for easements constitute a wide
3236 range of habitat protection. Thus, it is difficult to draw conclusions as to how easements/titles are
3237 contributing to Northern Spotted Owl conservation. Additionally, these areas are not rigorously studied
3238 specific to the Northern Spotted Owl.

3239 *State Forests*

3240
3241 CAL FIRE operates eight Demonstration State Forests in California, totaling about 71,000 acres. A
3242 majority of these forests are actively managed as timberlands and annually produce on average about
3243 30 million board feet of wood. About 53,145 actively-managed acres of State Forest lands occur within
3244 the range of the Northern Spotted Owl; this includes Ellen Pickett State Forest (158 acres), Las Posadas
3245 State Forest (843 acres), Boggs Mountain Demonstration State Forest (3,425 acres), and Jackson
3246 Demonstration State Forest (48,719 acres). State Forests are intended to be used for experimentation
3247 and demonstration of various silvicultural methods for their economic and environmental/scientific
3248 value. The State Forests have management plans that are periodically reviewed by BOF and all timber
3249 harvesting activities on State Forests must comply with the Forest Practice Act and the Forest Practice
3250 Rules, including the measures to avoid take of Northern Spotted Owl found in Forest Practice Rules
3251 sections 919.9 and 919.10.

3252 Jackson Demonstration State Forest (JDSF) is the largest of the eight forests (49,000 acres) and
3253 represents nearly 70% of the total State Forest acreage in California. This forest has been managed and
3254 harvested since 1862 and was acquired by the State in 1947. Located in central Mendocino County, the
3255 forest consists primarily of coast redwood and Douglas-fir, with some old-growth coast redwood
3256 remaining. Forest stands on JDSF have been managed on an even-aged and uneven-aged basis under
3257 various silvicultural systems; however, special restrictions are put on even-aged management and clear-
3258 cutting (CDF 2008, CDF 2014).

3259 The JDSF Management Plan (CDF 2008) contains a Northern Spotted Owl Conservation Strategy, with
3260 the goal to “maintain or increase the number and productivity of nesting owl pairs through forest
3261 management practices that enhance nesting and roosting opportunities and availability of a suitable
3262 prey base.” CAL FIRE monitors certain Northern Spotted Owl activity centers on JDSF and the
3263 Management Plan conditions are nearly identical to the Forest Practice Rules.

3264 *State Parks*

3265
3266 The California Department of Parks and Recreation (CA State Parks) manages 280 park units in
3267 California; 64 of these park units are within the range of the Northern Spotted Owl, totaling 214,286

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3268 acres. CA State Parks’ mission, in addition to preserving biodiversity, includes protecting cultural
3269 resources and creating recreation opportunities. CA State Parks does not have a management plan for
3270 the Northern Spotted Owl and management for species occurs at the park unit scale. Each park unit
3271 prepares a general plan that describes the range of activities occurring within the park unit and resource
3272 protection that the park unit enables.

3273 The largest State Park (SP) in the Northern Spotted Owl range, Redwood National and State Parks, is
3274 jointly managed by the NPS and CA State Parks and includes: Redwood National Park, Jedediah Smith
3275 Redwoods SP, Del Norte Coast Redwoods SP, and Prairie Creek Redwoods SP. RNSP does not have
3276 specific Northern Spotted Owl management actions in its General Management Plan/General Plan, but
3277 does have vegetation management actions for old-growth, second-growth, prairie and fires. Old-growth
3278 forests are protected, managed, and restored to provide habitat for species and to reduce fire hazards.
3279 Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to
3280 reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak
3281 woodlands and prairies is managed through tree removal and burning. Nine management zones within
3282 the RNSP delineate the degree of human influence and development on that can occur on the landscape
3283 (NPS 2000a).

3284 Similar to Redwood National and State Parks, the second largest park unit within the Northern Spotted
3285 Owl range, Humboldt Redwoods State Park, does not engage in specific management activities for
3286 Northern Spotted Owl, but protects and manages for old-growth stands to be sustained over time (CDPR
3287 2001).

3288 California State Parks do not engage in regular surveys for Northern Spotted Owl within State Parks,
3289 though surveys sometimes occur before park projects are started. However, adjacent timberland
3290 owners routinely survey Northern Spotted Owl activity centers within State Parks (T. Fuller, personal
3291 communications, September 2, 2014).

3292 *University of California Natural Reserves*

3293
3294 Comprised of more than 756,000 acres across 39 sites and representing most major California
3295 ecosystems, the UC Natural Reserve System (UCNRS) is the largest university-administered reserve
3296 system in the world. By supporting university-level teaching, research, and public service, the UCNRS
3297 contributes to the understanding of and wise stewardship of California’s natural resources. Five UCNRS
3298 sites (totaling 4,625 acres) across California occur within the range of the Northern Spotted Owl, though
3299 there are no management plans or Northern Spotted Owl SO data for individual reserves (UC 2014).
3300 Angelo Coast Range Reserve has had three Northern Spotted Owl territories through since the late-
3301 1980s, but since Barred Owls were detected in the area starting in 1999 Spotted Owls have not been
3302 detected at any of the three sites (A. Franklin, personal communication, March 23, 2015).

3303 *Department Ecological Reserves*

3304
3305 Authorized by the California Legislature in 1968 and administered by the Department, the ecological
3306 reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats,

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3307 and to provide areas for education and scientific research. The system now encompasses 119 properties
3308 totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur
3309 within the range of the Northern Spotted Owl; however there are no management plans for the system
3310 or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception
3311 is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by
3312 BLM, which manages for late seral habitat benefiting Spotted Owls.

3313 *Fisheries Restoration Grant Program*

3314 As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern
3315 Spotted Owls and their habitat are required for each project funded. The purpose of FRGP is to support
3316 restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must
3317 provide a detailed proposal that thoroughly addresses all criteria of the FRGP, one of which is avoidance
3318 and minimization measures for Northern Spotted Owls if a project proposes to conduct work in owl
3319 habitat. The geographic area covered by FRGP almost completely overlaps with the Northern Spotted
3320 Owl range in California, therefore the potential for a project be in owl habitat is high. Once a project is
3321 approved, the proponent must obtain a Lake or Streambed Alteration Agreement (LSAA) from the
3322 Department to comply with the CEQA. The LSAA will include conditions for the protection of wildlife and
3323 habitat, and must be followed during project activities.

3324 To avoid potential impacts to Northern Spotted Owls FRGP projects must adhere to the following, as
3325 noted in the LSAA:

- 3326 • Work with heavy equipment at any site within 0.25 miles of suitable habitat for the Northern
3327 Spotted Owl shall not occur from November 1 to July 9.
- 3328 • The work window at individual work sites may be advanced prior to July 31, if protocol surveys
3329 determine that suitable habitat is unoccupied.
- 3330 • If these mitigation measures cannot be implemented or the project actions proposed at a
3331 specific work site cannot be modified to prevent or avoid potential impacts to Northern Spotted
3332 Owls or their habitat, then activity at that work site will be discontinued and the project
3333 proponent must obtain incidental take authorization from the USFWS.
- 3334 • For projects contained within streams and watersheds included in a USFWS Habitat
3335 Conservation Plan the mitigation measures contained within those Habitat Conservation Plans
3336 shall be followed.

3337 The grant program is very successful and funds numerous projects each year. In fiscal year 2013/2014
3338 alone, FRGP funded approximately \$16.5 million dollars in 56 projects, of which 44 projects were located
3339 within the range of the Northern Spotted Owl.

3340 **Threats (Factors Affecting Ability to Survive and Reproduce)**
3341

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3342 **Historical Habitat Loss and Degradation**

3343 *Historical Habitat Loss*

3344 Historical (pre-logging) variability in forest age and structure in the range of the Northern Spotted Owl
3345 was controlled by natural processes, including wildfires (Courtney et al. 2004). Estimates of pre-logging
3346 extent of old forest in western Washington and Oregon are relatively consistent and range from 60 to
3347 72% of the landscape (Courtney et al. 2004). When the USFWS listed the Northern Spotted Owl as
3348 threatened in 1990, estimates of historical Spotted Owl habitat loss ranged from 60 to 88% loss
3349 rangewide since the early 1800s (USFWS 2011a). Much of this loss was attributed to timber harvest and
3350 to land-conversion, and was concentrated mostly at lower elevations and in the Coast Ranges (USFWS
3351 2011a). This pattern of historical loss is apparent in the current distribution of suitable habitat, with
3352 large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat
3353 (see Figure 4).

3354 Prior to 1990, the annual rate of removal of Spotted Owl habitat on national forests as a result of logging
3355 had been about 1% per year in California and 1.5% per year in Oregon and Washington (USFWS 1990,
3356 2011). At the time, it was projected that future rates of habitat removal would eliminate all nesting and
3357 roosting habitat on non-protected BLM lands in Oregon, with the exception of the Medford District, by
3358 the year 2016 (USFWS 1990). Estimates from the decades before 1990 indicate that harvest rates on
3359 private industrial lands were consistently about twice the average rate of harvest on public land (Cohen
3360 et al. 2002). Regarding harvest rates on private industrial and non-industrial lands, Bigley and Franklin
3361 (2004) estimated harvest rates in the late 1980s and early 1990s for private industrial land of 2.4% per
3362 year, and harvest rates on non-industrial lands increased from 0.2% in the 1970s to a rate similar to that
3363 of the private industrial lands by the early 1990s.

3364 *Assessing Habitat Loss through Implementation of the Northwest Forest Plan*

3365 The Northern Spotted Owl was listed under the federal Endangered Species Act in 1990 in part because
3366 of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised
3367 recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls,
3368 ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or degradation from stand
3369 replacing wildfire and other disturbances, and loss of amount and distribution of Spotted Owl habitat as
3370 a result of past activities and disturbances (USFWS 2011a). To address ongoing decline of Northern
3371 Spotted Owl habitat across the range, the NWFP established reserved lands including late-seral reserves,
3372 adaptive management reserves, congressionally reserved lands, managed late-successional areas, and
3373 larger blocks of administratively withdrawn lands (USDA and USDI 1994) (Figure 11). These are described
3374 in more detail above. It was assumed that habitat in reserves would improve over time as successional
3375 processes led to more mature forests, however, this is a slow process and so recruitment of habitat
3376 conditions on reserves was expected to take many decades. It was also assumed that habitat outside of
3377 reserves would continue to decline due to timber harvest and other disturbances but that dispersal
3378 habitat would be maintained in order to facilitate movement between reserve lands. Given the

Comment [JEH15]: But you define historical as pre-logging. Need to clean this up.

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3379 continued Northern Spotted Owl population declines and the increasing threat of the Barred Owl, the
3380 revised recovery plan recommended conserving occupied sites and unoccupied, high-value Spotted Owl
3381 habitat on state and private lands wherever possible (USFWS 2011a).

3382 In order to understand the degree to which the NWFP contributes to conservation of owl habitat, the
3383 rangewide trends in habitat are regularly assessed. To date, assessments have been performed at the
3384 10-year and 15-year time points (Davis and Lint 2005, Davis et al. 2011). The recent assessment
3385 estimated rangewide habitat changes on federal and nonfederal lands from 1994 through 2007 for
3386 California and from 1996 through 2006 in Oregon and Washington by comparing vegetation maps for
3387 two bookend time periods. In addition to rangewide changes, trends for each physiographic province
3388 and for each state are also reported (Davis et al. 2011). The assessment tracks changes in Northern
3389 Spotted Owl nesting and roosting habitat, and also tracks changes in dispersal habitat within and
3390 between the reserves. Foraging habitat is not assessed through modeling for the NWFP. Nesting and
3391 roosting habitat maps were produced through habitat suitability modeling using several forest structure
3392 variables (e.g., percent conifer cover, average conifer dbh, average stand height) and a forest age
3393 variable (Davis et al. 2011). Vegetation stands were placed in one of four categories (highly suitable,
3394 suitable, marginal, and unsuitable), with highly suitable and suitable categories assumed to represent
3395 nesting and roosting habitat (Davis et al. 2011). To assess change, an area was considered to have lost
3396 nesting and roosting habitat if its condition moved from suitable or highly suitable to marginal or
3397 unsuitable.

3398 Although federal lands contain less than half of the total forest land within the entire range of the
3399 Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and
3400 roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and
3401 roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands
3402 lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal
3403 lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance
3404 (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost
3405 on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the
3406 fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl
3407 range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands
3408 has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only
3409 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on
3410 nonreserved lands.

3411 Conversely, on nonfederal lands most of the nesting and roosting habitat loss was due to harvest (about
3412 625,600 acres; 14.9%). On nonfederal lands in Oregon and Washington, the extent of older forest
3413 harvested annually declined following implementation of the NWFP. However, this decline was likely
3414 due to exhaustion of the available inventory, as the annual harvest rate stayed relatively steady when
3415 measured as a percentage of the remaining older forest (Healey et al. 2008). A relatively small amount
3416 of nesting and roosting habitat on nonfederal lands was lost to fire, insects, and disease (0.6%; about
3417 23,700 acres).

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3418 Relative rates of nesting and roosting habitat loss on federal vs. nonfederal lands in California follow the
3419 rangewide pattern. Consistent with the entire subspecies range, loss of nesting and roosting habitat on
3420 federal lands in California was mostly due to wildfire and other natural disturbances (4.2%; 77,500
3421 acres), with a higher rate of loss than on federal lands rangewide (2.8%) (Davis et al. 2011). Most of the
3422 loss to natural disturbance in California occurred in the Klamath Province (73,200 acres), with almost all
3423 of the loss due to wildfire (Davis et al. 2011). Harvest rate of nesting and roosting habitat on federal
3424 lands in California was fairly low and matched that of federal lands rangewide (0.6%; 11,200 acres),
3425 although 3.0% of the nesting and roosting habitat on federal lands in the California Cascades Province
3426 was harvested (6,500 acres), which was the highest rate of harvest on federal lands across all provinces
3427 rangewide (Davis et al. 2011).

3428 As with the rangewide pattern, nonfederal lands in California experienced much greater loss of nesting
3429 and roosting habitat to harvest than to natural disturbance. The acreage of nesting and roosting habitat
3430 harvested on non-federal lands in California was about 90,200 acres (5.8%), which exceeds the total
3431 amount of habitat loss on federal lands in California (Davis et al. 2011). This is consistent with the
3432 rangewide pattern showing that the bulk of total nesting and roosting habitat loss has been due to
3433 harvest on nonfederal lands; although the majority occurred in Washington and Oregon, more nesting
3434 and roosting habitat was lost to harvest on non-federal lands (about 625,600 acres) rangewide than
3435 total loss on federal lands from harvest and natural disturbance combined (about 298,600 acres total)
3436 (Davis et al. 2011). California has more nesting and roosting habitat on nonfederal lands than either
3437 Washington or Oregon but has lost relatively less due to harvest, with Washington and Oregon losing
3438 18.6% and 21.8%, respectively, compared to 5.8% in California (Davis et al. 2011). This is likely due to
3439 differences in habitat retention requirements in the regulations of each state. On nonfederal lands in
3440 California, nesting and roosting habitat loss to natural disturbance was relatively low at 0.4% (about
3441 7,500 acres) (Davis et al. 2011).

3442 Davis et al. (2011) estimated amount of dispersal habitat across the range of the Northern Spotted Owl
3443 at the start of the NWFP and at the end of the study period (2006 or 2007 depending on location) by
3444 querying GIS vegetation databases for forests with conifer dbh ≥ 11 inches and conifer cover $\geq 40\%$ (see
3445 Figure 5). This is similar to the definition of minimum dispersal habitat from Thomas et al. (1990).
3446 Modeled nesting and roosting habitat was also included in the mapped dispersal habitat because owls
3447 will disperse through forests meeting the requirements of nesting and roosting habitat. Trends in
3448 dispersal habitat over the study period were analyzed within and between federal reserved lands. The
3449 distribution of “dispersal-capable” habitat was also mapped by combining results of the mapped
3450 dispersal habitat with estimates of maximum dispersal distance from Forsman et al. (2002) (Figure 17).
3451 This estimate of dispersal-capable habitat on the landscape allowed for a measure of the ability of owls
3452 to disperse between habitat reserves, which is a goal of the NWFP and an important functional measure
3453 of habitat beyond a simple acreage estimate of total dispersal habitat.

3454 Increases in dispersal habitat, as defined by conifer forests exceeding 11 inches dbh and 40% canopy
3455 cover, occurred through forest succession and through partial disturbance of nesting and roosting
3456 habitat to smaller, more open forest. Recruitment of dispersal habitat exceeded loss rate for a net

Comment [JEH16]: Identical to the definition in Thomas et al.? Check.

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increase of 5.2% rangewide (Davis et al. 2011). However, given the distribution of habitat increases and losses, the dispersal-capable habitat on the landscape decreased by about 1% (Davis et al. 2011); on federal lands this loss was largely due to wildfire (Figure 18). Losses of dispersal-capable habitat occurred mostly around the periphery of federal forests; Davis et al. (2011) suspect this is due to timber harvesting on nonfederal lands that border federal lands. Gains in dispersal-capable habitat also often occurred at the periphery of federal forests, as forest succession in younger or recently harvested forests led to forests meeting the minimum dispersal requirements.

The network of large federal reserves across the range of the Northern Spotted Owl is fairly well connected, although there are exceptions in the Olympic Peninsula, the eastern Washington Cascades, and in the southern end of the range in California. The Marin County population is poorly connected to other federal reserves, and large portions of the California Coast physiographic province are mapped as having poor dispersal-capability. However, the definition of minimum dispersal habitat in Thomas et al. (1990) and used to map trends in the NWFP may not capture the full range of dispersal habitat conditions in Northern California, where Northern Spotted Owls use younger forests (USFWS 2011a).

Timber Harvest

Timber Harvest on Private Land

The Northern Spotted Owl was federally listed as Threatened in 1990 larger due to extensive habitat loss from timber harvest activities on federal and nonfederal land. In 1991, the California Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] were enacted, which describe options and procedures that can be used in THPs to avoid take of Northern Spotted Owl or to proceed under incidental take authorization. Compliance with the Forest Practice Rules apply to all commercial timber harvesting operations for private landowners (excluding specific exemptions discussed in the Timber Harvest Management section of this report) from small parcels operations to large timber operations. Forest Practice Rules 919.9[939.9] specify subsections (a) through (g), which give the landowner options among which to select and follow for timber harvest within the range of the Northern Spotted Owl.

THPs are plans submitted by the landowners that serve as the environmental review document and they outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment, including impacts to Northern Spotted Owl activity centers. NTMPs are plans meant to promote the long term management and planning on forest ownerships of 2,500 acres or less, and they allow an alternate to submitting individual THPs prior to harvest. Landowners with approved NTMPs agree to manage their forests through uneven-aged management and long-term sustained yield.

As detailed in the Timber Harvest Management section of this report, the Department evaluated a subset of THPs and NTMPs submitted that fell within the range of the Northern Spotted Owl. Evaluation effort for each plan type varied depending on time constraints and level of information that was readily available, and included a summary of number of THPs submitted, types of silvicultural methods most used, and acres of habitat proposed for harvest and retention. For THPs, all plans submitted in 2013

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were evaluated, and a subset of Northern Spotted Owl activity centers from plans utilizing Option (e) and (g) (the most commonly used options from Forest Practice Rules 919.9[939.9]) were followed back in time to summarize cumulative harvest activities impacting the owl sites. For NTMPs, plans submitted within interior counties from 1991-2014 were evaluated, and plans submitted within coastal counties from 2005-2014 were evaluated.

Within the interior THPs evaluated, the Alternative method was proposed more than any other method, covering 9,798 acres within 1.3 miles of an activity center, and covered more than half of the total acreage. An Alternative silvicultural prescription can be included in a timber harvest plan when an alternative regeneration method or intermediate treatment is more effective or more feasible than any of the standard silvicultural methods (see Appendix 1). For plans using the Alternative method in the interior, the majority of THPs identify Clear Cut as the silvicultural method most similar to the Alternative method used. On the coast the Variable Retention was used on 28,144 acres within 0.7 miles of an activity center, far more area than all other methods combined. Forest Practice Rules Section 913.4(d) defines Variable Retention as an approach to harvesting based on the retention of structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for integration into the post-harvest stand to achieve various ecological, social and geomorphic objectives (see Appendix 1).

Of the NTMPs evaluated, Selection, Group Selection, and Uneven-aged silvicultural methods are the most utilized prescriptions throughout. Uneven-aged was a term used by many plan submitters through the 1990's and up until around 2007, and encompasses any silvicultural method that may use Selection, Group Selection, Sanitation Salvage, Variable Retention, or Alternative prescriptions. Uneven-aged management means the management of a specific forest, with the goal of establishing a well-stocked stand of various age classes which permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop (see Appendix 1). Most NTMPs evaluated that used the Uneven-aged silvicultural method did not delineate acres that would fall under each category, therefore there is limited ability to assess the type of harvest applied on the landscape. Under the Selection and Group Selection methods, the trees are removed individually or in small groups sized within areas of 0.25 to 2.5 acres.

Types of silvicultural practices vary on the landscape and may impact Northern Spotted Owls differently depending on a variety of factors surrounding type and extent of habitat removed. For example Clear Cut harvesting (removal of an entire stand in one harvest), depending on how it is applied on the landscape, has a potential to negatively impact Northern Spotted Owls. Impacts from harvest have been recognized in the literature since the time the owl was federally listed (UFWS 2011a). Yet implementation of other frequently used silvicultural methods (e.g., Alternative, Variable Retention, Group Selection, Uneven-aged) have less obvious impacts to Northern Spotted Owl foraging, nesting, and roosting habitat. Some harvest methods may serve to reduce habitat quality by removing key components of owl habitat near Northern Spotted Owls activity centers. For example, thinning has been shown to decrease the abundance of Northern Flying Squirrels and Red Tree Voles, two important prey species for Northern Spotted Owls (Wilson and Forsman 2013). Alternatively, applied at appropriate scales, some methods may in fact serve to enhance owl habitat, for example, by increasing foraging opportunities. Given the potential of both negative and positive impacts to the Northern Spotted Owl,

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3534 more thorough documentation and rigorous evaluation of harvest type and actual harvest levels of
3535 foraging, nesting, and roosting habitat, within harvest plans are needed. In addition, research is needed
3536 to provide a clearer understanding of the effects of silvicultural practices on important prey species
3537 habitat.

3538 To evaluate the level of impact of proposed harvest and retention to Northern Spotted Owl activity
3539 centers, each interior and coastal THP utilizing Option (e) and Option (g) in 2013 within the region was
3540 assessed further. Retention and harvest were assessed at two scales for interior THPs: within 0.5 miles
3541 and between 0.5 and 1.3 miles of an activity center. For coastal THPs, retention and harvest was only
3542 assessed within 0.7 miles of an activity center. For THPs utilizing Option (e), foraging habitat was the
3543 most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within
3544 0.5-1.3 miles). On the coast, foraging and nesting/roosting were retained at relatively similar levels
3545 within 0.7 miles (52,817 acres of foraging and 47,344 acres of nesting and roosting). For interior THPs
3546 utilizing Option (g) nesting/roosting (1,388 acres within 0.5 miles and 3,879 acres within 0.5-1.3 miles)
3547 and foraging habitat (1,032 acres within 0.5 miles and 3,171 acres within 0.5-1.3 miles) were similarly
3548 proposed for retention, and within the coast, more nesting/roosting habitat was retained (2,763 within
3549 0.7 miles).

3550 Timber harvest within the 0.5, 0.7 and 1.3 radii (representing different levels of habitat use by Northern
3551 Spotted Owls) has a potential to impact quality and extent of owl habitat, and consequently, owl fitness.
3552 Timber growth is slow, and consequently, regrowth of owl habitat is slow. Therefore, it is important to
3553 understand the cumulative impact to activity centers over time. As a way of evaluating this impact, the
3554 amount of habitat proposed for harvest was calculated for activity centers that were associated with
3555 THPs utilizing Option (e) and Option (g) submitted in 2013 were selected, and harvest history followed
3556 back in time. Of the 17 activity centers evaluated in the interior, six activity centers have experienced
3557 greater than 2,000 acres timber harvest cumulatively over time within the 1.3 mile radius (~3,400 acres)
3558 home range, and six activity centers have experienced greater than 250 acres timber harvest within the
3559 0.5 mile radius (~500 acres) core range. Of the 14 activity centers evaluated on the coast, six activity
3560 centers experienced harvest of over 500 acres, cumulatively, within the 0.7 mile radius (~985 acres) core
3561 range, with two of these over 1,000 acres (see Table 15, Table 16 and Appendix 3).

3562 Of the interior NTMPs evaluated, 19 (54%) were associated with at least one Northern Spotted Owl
3563 activity center within 1.3 miles of the plan boundary. Of the coastal NTMPs evaluated, 96 (78%) were
3564 associated with at least one activity center within 1.3 miles of the plan boundary. For NTMPs, it was
3565 difficult to assess the extent of harvest and habitat retention because the level of information available,
3566 particularly older plans, was limited in some cases. Considering NTMPs evaluated, we can infer that owl
3567 habitat is retained to some extent; however, we cannot determine the type or quality of habitat
3568 retained. For instance, high quality nesting and roosting habitat may be harvested more frequently,
3569 thereby reducing owl fitness.

3570 Several research studies have demonstrated a link between owl fitness and amount of habitat,
3571 structural characteristics, and spatial configuration (Franklin et al. 2000, Olson et al. 2004, Dugger et al.
3572 2005, Irwin et al. 2007) – see the Habitat Effects on Survival and Reproduction and the Habitat Loss and

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Degradation sections of this document. Given what we know about owl habitat and fitness, it is reasonable to believe that high levels of harvest, such as levels documented for some activity centers in the harvest analysis described above, can negatively impact Northern Spotted Owls. In some of the activity centers evaluated for harvest history, harvest cumulatively exceeded the guidance provided in the Forest Practice Rules regarding the amount of habitat retention. Furthermore, by comparing territory loss on private timber lands to USFS lands from 1978-2007 the USFWS (2009) found a 54% decline in pair status to no response and a 23% decline from pair status to single owl status on private timber lands, whereas on USFS lands 80% of the sites did not change pair status. These results suggest inefficiency in rules guiding timber harvest for the protection of Northern Spotted Owls.

Harvest of Hardwood Forests

The economic value of tree species growing on timberlands differs, with conifers being generally more valuable than hardwoods. The low value of hardwoods historically discouraged their harvest and removal from timberlands during commercial harvesting (Merenlender et al. 1996). The differential retention of hardwoods coupled with aggressive growth of tanoak during early successional processes lead many north coast timberlands to be heavily dominated by hardwoods.

To counter this history, the Forest Practice Rules (CCR 912.7, 932.7, and 952.7) provide timber resource conservation standards that require that the percentage of site occupancy of Group A (generally conifers) species to not be reduced relative to Group B species (generally hardwoods) as a result of harvest. The Forest Practice Rules specifically require retention of trees of each native commercial species inclusive of Group B hardwoods where present at the time of harvest in a limited number of silvicultural situations: during the seed step of shelterwood (913.1, 933.1, 953.1 (d)(2)(F)) and seed tree (913.1, 933.1, 953.1 (c)(1)(F)) silvicultural systems and only when applied in the absence of a Sustained Yield Plan. The purpose of this retention is to maintain and improve tree species diversity, genetic material and seed production, and is achieved by requiring the leave trees to be of the best phenotypes available. These trees need not be retained during the final, removal step. Otherwise, the Forest Practice Rules relegate hardwood retention during timber harvest to standards developed during plan development and agency review such as “Maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed” (CCR 897(b)(B)), and the “Hardwood Cover” evaluation requirements of the Cumulative Impacts Technical Rule Addendum #2 (CCR 912.9, , 932.9, 952.9 (c)(4)(e).

Outside of the timber harvest regulatory arena, some landowners are using techniques such as hack and squirt to ~~may be~~ actively suppressing hardwood competition with the more economically valuable conifers. In these situations, the Department has no authority to identify or mitigate impacts by recommending retention standards. Some landowners have developed internal standards that they apply during and outside timber harvest operations. While these may assure specimens and some level of hardwood function are retained on timberlands, the Department is unaware of the empirical support for the efficacy of these levels to provide spotted owl habitat and to support spotted owl forage base.

Comment [JEH17]: Mechanism? Not sure about this but if there were some permit or CEQA review required, wouldn't the authority of CDFW and USFWS to protect these resources already exist? The USFWS has the same problem as the Department on this issue.

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3610 *Regulatory Mechanisms Considerations*

3611 Changes in nesting and roosting habitat and dispersal habitat assessed for the NWFP have provided an
3612 assessment of broad landscape changes across the range of the Northern Spotted Owl, including
3613 changes specific to physiographic regions within California. As has been demonstrated at territory-based
3614 studies of habitat in California and southern Oregon, Northern Spotted Owl habitat is composed of a
3615 mosaic of mature forests intermixed with younger forest types within the home ranges of individual
3616 owls (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Irwin et al. 2007), with particular
3617 combinations providing high quality habitat. Some of the forest types included in high quality Northern
3618 Spotted Owl home ranges are younger forests, which would have been considered foraging habitat in
3619 the NWFP modeling, and therefore were not assessed for change in the recent review of the NWFP.
3620 Detection of changes in habitat quality at the smaller scale of Northern Spotted Owl home range
3621 requires an assessment of management practices at this scale, and can be accomplished by evaluating
3622 timber harvest practices around known Northern Spotted Owl activity centers.

3623 For core and home range habitat use, studies have documented a more concentrated and frequent use
3624 of habitat features surrounding the activity center (e.g., Hunter et al. 1995, ~~Bingham~~ Bingham and Noon
3625 1997, Meyer et al. 1998, Zabel et al. 2003, USFWS 2009). In addition, the shape of core area use varies
3626 due to the availability of nesting, roosting and foraging habitat, which deviates from the typical circular
3627 representation or core habitat use. The percent of older forest represented within the home range area
3628 varies from 30-60%, with an average of about 45% (USFWS 2009). For a more detailed discussion on
3629 core and home range use, see Biology and Ecology section of this report.

3630 As discussed in the Habitat Requirements section of this report, certain habitat characteristics have been
3631 shown to support high quality Northern Spotted Owl territories, with both the amount and spatial
3632 configuration of different habitat types at a territory contributing to levels of survival and productivity in
3633 the resident owls. This measure of habitat quality at the scale of Northern Spotted Owl home range has
3634 been termed “habitat fitness potential” (HFP; Franklin et al. 2000). See the Habitat Effects on Survival
3635 and Reproduction section of this report for a discussion of HFP and additional studies that have
3636 contributed to an understanding of habitat characteristics that provide high HFP. The studies that have
3637 evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types
3638 that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent
3639 and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

3640 The definition of take under federal ESA includes actions that would significantly modify or degrade
3641 ~~reduce the quality of~~ habitat; therefore, take avoidance recommendations by the USFWS can provide a
3642 reasonable baseline to assess impacts to habitat quality. Estimation of the likelihood of take according
3643 to Section 9 of the ESA would benefit from a better understanding between habitat quality and owl
3644 fitness. When the Forest Practice Rules were originally created, the criteria for owl habitat and retention
3645 were based on the best science and expert opinion at the time and lacked information on reproduction,
3646 survival and occupancy.

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3647 The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the
3648 Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls
3649 may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis
3650 conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from
3651 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory
3652 loss. They found on private timber lands there was a 54% decline in pair status to no response, and a
3653 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change
3654 pair status. A lack of owl responses and a lack of suitable habitat to support continued occupancy and
3655 survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early
3656 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat
3657 characteristics to owl fitness, the USFWS asserted that the Forest Practice Rules were insufficient to
3658 adequately avoid take of Northern Spotted Owls (USFWS 2009), although we are not aware of any legal
3659 cases under the current regulatory framework.

3660 To address insufficiencies in the Forest Practice Rules, the USFWS used the results of demography
3661 studies (e.g., Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005) and additional studies on habitat
3662 selection by Northern Spotted Owl (e.g., Solis and Gutiérrez 1990, Zabel et al. 1993, Irwin et al. 2007), to
3663 develop harvest management guidelines for the interior and coast that would adequately avoid take of
3664 Northern Spotted Owl in California (USFWS 2008b). The purpose of the USFWS guidelines was to enable
3665 CAL FIRE to more effectively and appropriately evaluate THPs and NTMPs to result in timber harvest
3666 activities that do not result in take of owls according to ESA standards. To accompany the guidelines, the
3667 USFWS developed a white paper (USFWS 2009) describing the regulatory and scientific basis for
3668 developing the criteria within the guidance for the interior region of California. The USFWS did not
3669 develop a sister document for the coast region in California. Because criteria in the USFWS (2008)
3670 guidelines were developed using the most up to date scientific information for habitat effects on owl
3671 fitness within the core and home range areas, the guidelines differ somewhat from the Forest Practice
3672 Rules. Criteria noted in the Forest Practice Rules Section 919.9 subdivision (g) and the USFWS 2008 and
3673 2009 guidelines are summarized in Tables 20, 21 and 22 below. Definitions of owl habitat referred to in
3674 Forest Practice Rules Section 919.9(g) can be found in Appendix 2.

3675 Among the recommendations in the USFWS guidance to CAL FIRE (USFWS 2008b), minimum amounts of
3676 nesting, roosting, and foraging habitat are described for both 0.5 mile (502 acres; interior forests) and
3677 0.7 mile (985 acres; coastal forests) radius surrounding the activity center, representing the core habitat
3678 use, and for an outer ring of habitat from 0.5 to 1.3 miles radius (2,908 acres; interior forests)
3679 surrounding the activity center, representing broader home range. The USFWS determined that within
3680 the interior forests in California, 0.5 mile radius, rather than the 0.7 mile radius noted in the Forest
3681 Practice Rules, more effectively captured actual core habitat use of Northern Spotted Owls (USFWS
3682 2009). The 2008 USFWS guidelines also revised the definitions of nesting, roosting, and foraging habitat
3683 for the interior, and included differentiation between high quality and low quality habitat (USFWS 2008b
3684 and USFWS 2009). Although assumptions were required in order to develop a single set of guidelines for
3685 the interior forests, the amount and spatial configuration of habitat to be retained is consistent with
3686 what was found in studies that evaluated habitat quality as a function of owl fitness.

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When the Northern Spotted Owl guidelines were added to the Forest Practice Rules in 1992, the intent was to protect Northern Spotted Owls and suitable habitat used for nesting, roosting and foraging. Since that time, additional scientific literature (e.g., Franklin et al. 2000, Irwin et al. 2000, Zabel et al. 2003, Courtney et al. 2004, Dugger et al. 2005, Glen et al. 2004, Olson et al. 2004, Irwin et al. 2007) has been published that helps to further elucidate habitat use of Spotted Owls and associations between habitat and owl fitness. It is also known that response and occupancy rates have declined at some historical activity centers. Though the specific reasons why response and occupancy rates have declined are unknown, there are multiple likely factors including cumulative habitat loss and degradation, and presence of Barred Owl. Given this broad range of possibilities, the Forest Practice Rules may not be sufficient at protecting loss of Northern Spotted Owl habitat within its range in California.

Table 20. Criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted Owls on private timberlands according to Forest Practice Rules Section 919.9(g).

Forest Practice Rules Subsection	Proximity to Activity Center (acreage)	Criteria Description
919.9(g)(1)	Within 500 feet of the activity center (~18 acres)	Characteristics of functional nesting habitat must be retained.
919.9(g)(2)	Within 500-1000 feet of the activity center (1,000 foot radius circle is ~72 acres)	Retain sufficient functional characteristics to support roosting and provide protection from predation and storms.
919.9(g)(3)	Within a 0.7 mile radius of the activity center (~985 acres)	Provide 500 acres of owl habitat. The 500 acres includes the habitat retained in subsections 919.9(g)(1) and (2) and should be as contiguous as possible.
919.9(g)(4)	Within 1.3 miles of each activity center (~3,400 acres)	Provide 1,336 total acres of owl habitat. The 1,336 acres includes the habitat retained within subsections 919.9(g)(1)-(3).
919.9(g)(5)	Shape of habitat retention	Areas established shall be adjusted to conform to natural landscape attributes such as draws and stream courses while retaining the total area required within subsections 919.9(g)(1) and (2).

3699

Table 21. USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted Owls on private timberlands, and selected stand structural parameters used to classify nesting/roosting and foraging habitat for Northern Spotted Owls in the northern coastal region of California (USFWS 2008b).

Habitat Type	Acre Retention in Core Area (within 0.7 mile; ~985 acres) ¹	Acre Retention in Outer Ring (between 0.7-1.3 mile) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	DBH	Percent Canopy Cover	Basal Area
Nesting/Roosting	200 acres	NA	200 acres	≥ 11 inch	≥ 60%	≥ 100 ft ² /acre
Foraging	≥ 300 acres	NA	≥ 300 acres	≥ 11 inch	≥ 40%	≥ 75 ft ² /acre
Suitable Habitat ²	NA	≥ 836 acres	≥ 836 acres			

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3704 ¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the
3705 plan.
3706 ² Suitable Habitat is defined as habitat that meets either Nesting/Roosting or Foraging definitions, or a combination of
3707 Nesting/Roosting and Foraging habitat.

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3708 **Table 22.** USFWS guidelines criteria for minimum quantities of habitat to be retained to avoid incidental take of Northern Spotted Owls on private timberlands,
3709 and selected stand structural parameters used to classify nesting/roosting and foraging habitat for Northern Spotted Owls in the northern interior region of
3710 California (USFWS 2008b and 2009).

Habitat Type	Within 1,000 feet of Activity Center	Acre Retention in Core Area (within 0.5 mile; ~500 acres) ¹	Acre Retention in Outer Ring (between 0.5-1.3 mile; ~2,900 acres) ¹	Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)	Basal Area Parameter	Quadratic Mean Diameter Parameter	Large trees/acre Parameter	Canopy Closure Parameter
High Quality Nesting/Roosting	No timber operations are allowed other than use of existing roads.	100 acres	NA	100 acres	≥ 210 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Nesting/Roosting		150 acres	NA	150 acres	Mix, ranging from 150 to ≥ 180 ft ² /acre	≥ 15 inch	≥ 8	≥ 60%
Foraging		100 acres	655 acres	755 acres	Mix, ranging from 120 to ≥ 180 ft ² /acre	≥ 13 inch	≥ 5	≥ 40%
Low-quality Foraging		50 acres	280 acres	330 acres	Mix, ranging from 80 to ≥ 120 ft ² /acre	≥ 11 inch	NA	≥ 40%

¹ No more than 1/3 of the remaining suitable habitat may be harvested within the core area and outer ring during the life of the plan.

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3713 A comparison of the habitat definitions and retention requirements in Section 919.9(g) of the Forest
3714 Practice Rules (Appendix 2 and Table 20) and the revised take avoidance guidance provided by the
3715 USFWS (2009; summarized in Table 21 and 22) reveals how implementation of the Forest Practice Rules,
3716 as written, may result in degradation of habitat quality around Spotted Owl activity centers in the
3717 interior portion of the range. The definition of functional nesting habitat under the Forest Practice Rules
3718 might be adequate to provide suitable nesting or roosting habitat for spotted owls, although the
3719 average stem diameter is less than that recommended by the USFWS. The functional roosting habitat
3720 under Forest Practice Rules does not meet the requirements of roosting habitat under the USFWS
3721 recommendation; habitat falling under the roosting habitat definition would be considered low-quality
3722 foraging habitat under the USFWS recommendations. Functional foraging habitat as defined under
3723 Forest Practice Rules might meet the requirements for low-quality foraging habitat as defined by
3724 USFWS, but does not meet the requirements of foraging habitat.

3725 Under the Forest Practice Rules minimum retention requirements, stands that meet the USFWS
3726 recommendation for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
3727 The habitat retained within 1,000 feet (~72 acres) would be defined as low-quality foraging habitat in
3728 the USFWS guidance. Because the 500 acres of spotted owl habitat to be retained within 0.7 miles and
3729 the total of 1,336 acres to be retained within 1.3 miles of an activity center can be composed of
3730 functional foraging habitat, there is no requirement in the Forest Practice Rules for the retained habitat
3731 within 0.7 or 1.3 miles of the activity center to include nesting or roosting habitat. Also, using the revised
3732 habitat definitions provided by USFWS (2009), this retained foraging habitat could be of low quality.
3733 Although similar acreage of habitat is retained under the Forest Practice Rules and the USFWS
3734 recommendations, very little of the habitat retained under Forest Practice Rules is required to meet the
3735 requirements of nesting or roosting habitat. Consequently, depending on how the rules are
3736 implemented, management could result in a reduction in habitat quality around Northern Spotted Owl
3737 sites and could lead to declines in survival, productivity, and overall fitness.

3738 **Habitat Loss from Marijuana Cultivation**

3739 Large-scale marijuana cultivation in remote forests throughout California has increased since the mid-
3740 1990s, coinciding the time the “Compassionate Use Act” was passed in 1996 (Proposition 215) that
3741 allows the legal use and growth of marijuana for certain medical purposes (Bauer et al. 2015). Within
3742 the range of the Northern Spotted Owl, Shasta, Tehama, Humboldt, Mendocino, and Trinity counties
3743 comprise the areas known for the most marijuana cultivation in California due to the remote and rugged
3744 nature of the land, making cultivation difficult to detect (National Drug Intelligence Center 2007, Bauer
3745 et al. 2015). Illegal marijuana cultivation grows on public and private land are widespread in California
3746 (Gabriel et al. 2013, Thompson et al. 2013, Office of National Drug Control Policy 2015), and may also
3747 negatively impact owl habitat through degradation and removal, though data on the extent of this
3748 impact is not well known. The Office of National Drug Control Policy (2015) reported that in 2012 3.6
3749 million plants were eradicated from 5,000 illegal outdoor marijuana grow sites in the United States, of
3750 which 43% were removed from public and tribal lands. Additionally, the USFS reported that 83% of the
3751 plants removed were from California (Office of National Drug Control Policy 2015). Areas with higher

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3752 prevalence of marijuana cultivation may also contain high numbers of Northern Spotted Owl activity
3753 centers (see Figure 3), especially in areas where riparian habitat exists.

3754 As discussed previously, for typical timber harvest activities, land owners are bound by the Forest
3755 Practice Rules and would therefore need to submit a THP, Spotted Owl Management Plan, Spotted Owl
3756 Resource Plan or exemption notification to the appropriate governing agencies. However, small scale
3757 timber removal in association with legal marijuana cultivation on private land does not require review or
3758 approval from state or federal governments as long as the timber is not sold. Habitat alteration also
3759 occurs in association with illegal marijuana grow sites, but the extent is not well known due to the
3760 secretive nature of these activities. Therefore, loss of timber and other habitat components important
3761 to Northern Spotted Owls (e.g., riparian habitat alterations) for the cultivation of marijuana for such
3762 purposes is largely unregulated.

3763 To date, there has been no study that analyzes the impact of marijuana cultivation sites on Northern
3764 Spotted Owl habitat or fitness. However, there is a potential for negative impacts of sites placed on
3765 private and public land within the owl's range. The level of impact would likely depend on density of
3766 cultivation sites in proximity to owl activity centers, and whether sites are placed within suitable owl
3767 habitat.

3768 In an effort to assess potential environmental impacts to aquatic ecosystems from legal marijuana
3769 cultivation, Bauer et al. (2015) delineated cultivation sites (outdoor plantations and greenhouse
3770 locations), using Google Earth satellite imagery from 2011 and 2012, within four watersheds (hereafter
3771 referred to as the study area): Upper Redwood Creek, Redwood Creek South, and Salmon Creek, located
3772 in Humboldt County; and Outlet Creek, located in Mendocino County. In addition to the Bauer et al.
3773 (2015) study area, cultivation sites in the Mad River Creek watershed, in Mendocino and Trinity
3774 counties, were also delineated due to interest in identifying potential impacts to aquatic species and
3775 water quality in that area. Cumulatively, these 5 watersheds represent approximately 4% of the
3776 Northern Spotted Owl range in California (Table 23). Within these watersheds, marijuana cultivation
3777 sites varied in size from 0.002 to 2.9 acres and comprised a total of 362 acres. This is a relatively small
3778 portion of the watersheds assessed.

3779 **Table 23.** The number of marijuana cultivation sites within each watershed, and area (acres) associated with each.
3780 Watersheds assessed are within Humboldt, Mendocino, and Trinity counties.

Watershed Name	Area (acres)	No. of Cultivation Sites	Total area (acres) of Cultivation Sites
Upper Redwood Creek	155,338	253	43
Redwood Creek South	16,653	369	53
Salmon Creek	23,489	515	42
Outlet Creek	103,554	795	90
Mad River Creek	321,972	416	134

3781

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To assess potential impacts to Northern Spotted Owls we assessed marijuana cultivation locations from 2011 and 2012 within the watersheds mentioned in Table 23, together with owl activity centers locations (Figure 19). We found that no activity centers were within delineated cultivation sites; however, 10 activity centers are within 0.5 miles of the cultivation sites, and 96 within 1.3 miles. Depending on the size of the site and how much suitable owl habitat is removed, impacts to owls may vary. The amount and type of owl habitat removed is summarized in Table 24. For the cultivation sites delineated in 2011 and 2012, much of the habitat removed was unsuitable for Northern Spotted Owls, with the exception of Mad River Creek watershed; here, 12.45 acres of highly suitable, 6.89 acres of suitable, and 22.91 acres of marginal owl habitat was removed.

Table 24. Level of owl habitat removed in each watershed.

Watershed Name	Highly Suitable	Suitable	Marginal	Unsuitable
Upper Redwood Creek	2.67	3.56	22.91	8.9
Redwood Creek South	1.11	1.33	14.90	32.47
Salmon Creek	0.00	0.89	12.23	20.68
Outlet Creek	3.56	5.56	15.35	38.25
Mad River Creek	12.45	6.89	22.91	8.90

As described elsewhere in this report, habitat removal, fragmentation, and degradation can all have varying degrees of negative impacts on spotted owls depending on how much suitable habitat is removed within their core range (e.g., represented by the 0.5 mile buffer surrounding the activity center) and within their home range (e.g., represented by the 1.3 mile buffer surrounding the activity center). Of the 362 acres of forestland or riparian habitat removed for marijuana cultivation, approximately 20 acres are within highly suitable Northern Spotted Owl habitat, 18 acres are in suitable habitat, and 97 acres are in marginal habitat. As an example of potential impacts to Northern Spotted Owl activity centers, Figure 20 shows a zoomed in area in Humboldt County where marijuana cultivation sites overlap the home range for several activity centers. One activity center displayed in Figure 20 experienced removal of 4.45 acres of highly suitable habitat, 0.67 acres of suitable, 4.45 acres of marginal, and 0.89 acres of unsuitable habitat within the 1.3 mile buffer.

The data used for this analysis comes with certain limitations when assessing long-term impacts to the Northern Spotted Owl. First, the dataset is a snapshot in time during 2011 and 2012 and does not represent expansion of cultivation sites since the data were collected. The data also only covers 4% of the Northern Spotted Owl range and therefore is only representing a small area of potential impact. Marijuana cultivation is occurring outside of the area assessed. To more fully consider impacts a similar analysis would have to be done within the entire range. In addition, smaller clearings (less than 10 mi²) are likely not captured in the dataset due to difficulties identifying and delineating smaller sites using aerial imagery and not all sites locations are reported as required by law. Sites likely have not been captured for other reasons as well; for example, some sites are intentionally placed in areas where they are harder to detect (e.g., sites with higher canopy closure). Law enforcement efforts and ground truthing helped fill in the gaps for the data collected in 2011 and 2012, but it is still uncertain how many

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sites were not accounted for. Lastly, there may be other activities associated with the cultivation sites not captured using this data that can also have an impact ~~in owl spotted owls~~ on spotted owls, such as placement of roads and vehicular traffic, other sources of noise disturbance during the breeding season, and improper pesticide use (see Contaminants section below).

Given above uncertainties regarding the dataset used in this analysis, it is plausible to assume that the density of cultivation sites is likely higher than represented in the dataset. In addition, given the density of cultivation sites within Humboldt, Trinity and Mendocino counties represented in this analysis, and the fact that the watersheds analyzed comprise only 4% of the Northern Spotted Owl range, it is also very plausible to assume that marijuana cultivation sites are impacting spotted owl habitat, thereby likely impacting fitness to some extent.

Wildfire

Effect of Wildfire and Salvage Logging

Wildfire is a natural process in California's forests, and in much of its range the Northern Spotted Owl has evolved in a landscape of frequent wildfire. Despite this, fire is often considered a primary threat to Northern Spotted Owl habitat due the owl's preference for older forests and the capacity of fire to rapidly remove or degrade habitat. The mature forests preferred by owls for nesting and roosting can take decades to centuries to develop following removal, depending on location and forest type and fire severity. The USFWS revised recovery plan (USFWS 2011) considered fire to be a primary threat to the Northern Spotted Owl, along with ongoing losses to timber harvest and competition with the Barred Owl. As discussed above, fire has become the primary cause of nesting and roosting habitat loss on federal lands since implementation of the NWFP, only surpassed by rangewide losses due to timber harvest, which have been concentrated on nonfederal land (Davis et al. 2011).

The majority of the natural disturbance loss (e.g., disease, insects, wildfires) of nesting and roosting habitat on federal lands since 1994 has occurred in the five relatively dry physiographic provinces (eastern Washington, eastern Oregon, and California Cascades; Oregon and California Klamath; Figure 21), with about 86% (211,300 acres) of the natural disturbance loss occurring in these provinces (Davis et al. 2011).

These dry provinces contain only about 42% of the total nesting and roosting habitat acreage on federal lands rangewide. Most habitat loss in the dry provinces was due to wildfire in the Oregon and California Klamath and the eastern Washington and eastern Oregon Cascades (Davis et al. 2011). Degradation of nesting and roosting habitat from fire was also estimated, with most degradation occurring in the western Cascades (Davis et al. 2011).

Research on the effect of wildfire on Spotted Owl habitat use and selection, occupancy, and survival has been conducted throughout the range of the species from eastern Washington and southern Oregon, in the Sierra Nevada mountains in the range of the California Spotted Owl, and in Arizona and New Mexico in the range of the Mexican Spotted Owl (e.g., Gaines et al. 1997, Bond et al. 2002, Jenness et al. 2004,

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3851 Bond et al. 2009, Clark et al. 2011, 2013). Studies to date are scattered throughout the range of the
3852 Spotted Owl and have generally been performed opportunistically due to the difficulties associated with
3853 experimental fire research in a natural setting; much uncertainty remains on the effect of wildfires on
3854 the extent and quality of Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates
3855 by Spotted Owls have been somewhat equivocal, in some cases showing that stand replacing wildfire
3856 has a negative impact on occupancy (e.g., Gaines et al. 1997), and in other cases showing no adverse
3857 impact of wildfire on Spotted Owl occupancy (e.g., Jenness et al. 2004). Here we focus on the relatively
3858 extensive studies from the Sierra Nevada Mountains in the range of the California Spotted Owl and from
3859 southwestern Oregon in the range of the Northern Spotted Owl, as these areas more closely represent
3860 the forest types within the interior range of the Northern Spotted Owl in California and are relatively
3861 well studied.

3862 In the southern Sierra Nevada, in areas with a mosaic of burned and unburned forests, California
3863 Spotted Owls have been shown to use forests that have experienced a full range of burn severities. Bond
3864 et al. (2009) found the degree to which a post-fire site was used varied with burn severity and with the
3865 function of the site in meeting various life history requirements (i.e., nesting, roosting, or foraging). This
3866 study occurred in an area that experienced the full range of burn severities, resulting in owl territories
3867 with a mosaic of all burn classes, ranging from unburned forests to areas with most of the overstory
3868 removed by fire (high-severity burn areas were defined as those resulting in high to complete mortality
3869 of dominant vegetation; low-severity burn areas were defined as those with little change in cover and
3870 little tree mortality; moderate-severity burn areas were those between high- and low-severity, with a
3871 mixture of effects on vegetation). Most California Spotted Owl roost sites (85%) occurred in unburned
3872 and low-severity burn areas, and owls avoided roosting in moderately and severely burned areas.
3873 Conversely, California Spotted Owls selected foraging sites represented by all severities of burned forest
3874 and avoided unburned forest (Bond et al. 2009). This study illustrated that California Spotted Owls use
3875 multiple forest types within a home range to meet nesting, roosting, and foraging needs, and that
3876 moderate to high severity fires may impact preferred nesting and roosting habitat while providing
3877 foraging habitat. In contrast to the findings of Bond et al. (2009), recent work on the impact of fire on
3878 foraging site selection by California Spotted Owls in Yosemite National Park showed that owls selected
3879 for areas of low-severity burns but avoided areas of high-severity burns (Eyes 2014). The owls that were
3880 tracked in the burned areas of the southern Sierra Nevada (Bond et al. 2009) were shown to have a diet
3881 composed of predominately pocket gophers (Bond et al. 2013), whereas the diet of California Spotted
3882 Owls in unburned forests was dominated by woodrats and northern flying squirrels, depending on
3883 location. Breeding home range sizes were similar for owls occupying burned and unburned areas (Bond
3884 et al. 2013). The apparent shift to an alternative prey source in the post-fire landscape of the Sierra
3885 Nevada may have allowed California Spotted Owls to effectively utilize high-severity burn areas and to
3886 maintain similar home range sizes.

3887 The use of a diverse forest composition in the Sierra Nevada is consistent with research conducted in
3888 the range of the Northern Spotted Owl that indicate high quality habitat is composed of older more
3889 mature forest among a mosaic of other forest types (Franklin et al. 2000, Olson et al. 2004). California
3890 Spotted Owls in the Sierra Nevada also selected for foraging sites that included edge between burned

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3891 and unburned forests and between burn areas of different severity classes (Bond et al. 2009). This is
3892 consistent with the above studies on Northern Spotted Owls which showed high quality habitat to have
3893 high amounts of edge between old forests and other forest types.

3894 In a study of post-fire occupancy at six fire sites across the range of the California Spotted Owl in the
3895 Sierra Nevada, Lee et al. (2012) found no difference in occupancy rates between burned and unburned
3896 sites. As with the above study on post-fire habitat selection, this study included fires with a range of
3897 burn severities, which is typical of fires in the Sierra Nevada (Odion and Hanson 2006). Of the six fires
3898 included in the study, on average 32% of the burned area was burned at high-severity so these results
3899 are applicable to mixed-severity fires that result in a mosaic of post-fire conditions. A subset of burned
3900 sites included in the study (9 of 41) burned at higher severity (>50% high severity burn of suitable owl
3901 habitat). Owls were detected at five of these nine sites post-fire (Lee et al. 2012), suggesting that sites
3902 that were exposed to higher amounts of high-severity fire might have experienced reductions in
3903 occupancy, but this was not modeled. Salvage logging of timber after a fire was known to occur on eight
3904 burned sites post-fire. California Spotted Owls initially occupied seven of the eight sites after the fire,
3905 but following the salvage logging none of the sites remained occupied. Post-fire logging may have
3906 adversely affected occupancy of burned sites but the sample size was too small for the effect to be
3907 modeled (Lee et al. 2012). An additional study in the Sierra Nevada compared occupancy rates at 10
3908 unburned sites to 9 sites that burned at low to moderate severity in Yosemite National Park and found
3909 no difference in occupancy rates between burned and unburned sites (Roberts et al. 2011). The study
3910 area was restricted to areas with $\geq 40\%$ canopy cover, and occupancy was positively correlated with total
3911 tree basal area and canopy closure (Roberts et al. 2011). This study did not address effects of high-
3912 severity fire, nor post-fire logging.

3913 In the range of the Northern Spotted Owl, the most extensive evaluation of the effect of fire on owls has
3914 been conducted on a group of three fires in the Klamath and Western Cascades physiographic provinces
3915 of southwest Oregon (Clark 2007, Clark et al. 2011, 2013). By tracking radio-marked owls with territories
3916 inside and adjacent to burned areas, Clark et al. (2011) were able to estimate the effects of fire on
3917 occupancy and survival of Northern Spotted Owls. The occurrence of a demographic study area (South
3918 Cascades) in proximity to the fires allowed for comparison of unburned areas to pre- and post- fire rates
3919 within the fire footprints. On one of the fire study areas (Timbered Rock fire), 22 territories had been
3920 surveyed for ten years pre-fire and so allowed for a comparison of pre- and post- fire occupancy.
3921 Occupancy at this site was compared to the nearby South Cascades study area and the two areas were
3922 shown to have similar trends in occupancy rates prior to the Timbered Rock fire in 2002. However,
3923 extinction rates in the Timbered Rock fire area increased after the fire, resulting in declines in occupancy
3924 (Clark 2007, Clark et al. 2013). Only 20% of territories at the Timbered Rock fire were occupied by a pair
3925 of owls by the end of the study period in 2006 (four years post fire), where >50% of territories had been
3926 occupied in all years pre-fire. These declines were not observed at the unburned South Cascades study
3927 area. Data collected at all three fires from 2003-2006 was used to model post-fire rates and suggested
3928 that high extinction rates and low colonization rates led to declines in post-fire occupancy (Clark 2007).

3929 On two of the burned areas in southwest Oregon (Timbered Rock and Quartz fires), 23 radio-marked
3930 Northern Spotted Owls were tracked over a one year period in order to estimate survival rates of owls

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3931 within and adjacent to burns. Mean annual survival rates of owls displaced by wildfire (0.66 ± 0.14) or
3932 occupying territories within the burned area (0.69 ± 0.12) were lower than those for owls outside of
3933 burned areas (0.85 ± 0.06) (Clark et al. 2011). Survival rates of owls outside of burned areas were similar
3934 to rates at the nearby unburned demographic study area (South Cascades; 0.85 ± 0.01) (Anthony et al.
3935 2006). The two fires included in the survival study each burned about 50% of the owl habitat at mixed
3936 severities from low to high, which is comparable to fires included in studies on California Spotted Owl in
3937 the Sierra Nevada. Of the 24 owls tracked, 5 died during the study. Necropsies were performed on 4 of
3938 these owls and showed that all were severely emaciated and likely died due to starvation (Clark et al.
3939 2011). This, and the fact that owls in the study maintained larger home ranges post-fire (Clark 2007),
3940 suggest that food limitation might have played a role in reduced survival rates. Also, the documented
3941 dispersal of several adult Northern Spotted Owls out of the burn area at the Timbered Rock fire 1-2
3942 years post-fire suggests that insufficient habitat remained at abandoned territories to support an owl
3943 pair (Clark et al. 2013). Both of the fire areas in this study were salvaged logged post-fire, with about
3944 20% of the area logged in each fire. See discussion on potential effects of salvage logging below.

3945 Using the telemetry data collected by Clark in southwest Oregon, Comfort (2013) evaluated selection of
3946 habitats relative to availability following mixed-severity fire disturbance. The strongest predictor of
3947 spotted owl presence was habitat suitability (as defined in the 10-year review of the Northwest Forest
3948 Plan (Davis and Lint 2005)). Northern Spotted Owls avoided large, contiguous patches of high-severity
3949 disturbance and preferentially used areas of lower severity disturbance (Comfort 2013). At small spatial
3950 scales (<0.8 ha), Spotted Owls did select for areas with hard edge created by high severity fire, but at
3951 larger spatial scales, hard edges were avoided. This suggests that at the scale of a home range, owls
3952 selected for large patches of contiguous high suitability habitat interspersed with small patches (<0.8 ha)
3953 of high severity fire or salvage logging (Comfort 2013). Because salvage logging occurred in the study
3954 area on private industry land, the analysis by Comfort did not distinguish between areas of high-severity
3955 burns and those that were salvage logged, but instead used the combined disturbance of fire and
3956 logging to evaluate owl use of different components of the landscape.

3957 An earlier study evaluated short term survival of Spotted Owls following wildfire by tracking color-
3958 banded owls which occurred on territories that later burned in a wildfire during a period from 1985-
3959 2001 (Bond et al. 2002). Because of the opportunistic nature of observations for this study, only 11
3960 territories were included in the study and they were distributed across the range of the species from
3961 California, Arizona, and New Mexico, and represented all three subspecies of the Spotted Owl. Twenty-
3962 one color-banded owls had occurred on the eleven territories pre-fire and 18 were resighted the year
3963 following fire (Bond et al. 2002). This represents a simple annual survival estimate of 86%, which is
3964 similar to reported estimates of survival in unburned areas. The short-term covered by the study (one
3965 year post-fire) and the small sample size limit the utility of the study in extrapolating to a general effect
3966 of fire on Northern Spotted Owls (of which four territories were included), but they do at least
3967 demonstrate that some wildfires have little short-term impact on Spotted Owl survival. Most territories
3968 in this study burned at low to moderate severity and no salvage logging had occurred between time of
3969 fire and the following year when resighting attempts occurred (Bond et al. 2002).

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3970 Post-fire declines in occupancy in southern Oregon contrast with most results for the California Spotted
3971 Owl in the Sierra Nevada. As mentioned above, two of three burn areas in southern Oregon underwent
3972 fairly extensive salvage logging post-fire. The studies conducted in the Sierra Nevada included some sites
3973 that were salvage logged, but sample sizes were too small to model the perceived effect of logging on
3974 occupancy. Several authors have suggested that salvage logging after a fire or occurrence of extensive
3975 high severity burns likely have contributed to a decline in habitat use, occupancy, or survival of Northern
3976 Spotted Owls (Bond et al. 2009, Roberts et al. 2011, Clark et al. 2011, 2013, Lee et al. 2012). With the
3977 exception of low severity burns, burned areas have generally not supported nesting habitat but have
3978 been shown in some cases to create foraging habitat. The presence of snags has been suggested as an
3979 important component of prey habitat and as perch sites for foraging Spotted Owls. We do not know of
3980 any research conducted on Northern Spotted Owl prey abundance in burned vs. unburned forests, but
3981 early successional forests have been shown to support abundant woodrat populations in the southern
3982 portion of the range (see discussion of prey in Life History section) and so burned areas may provide
3983 high quality prey habitat once vegetation regrowth produces an understory. Bond et al. (2009)
3984 concluded that the most likely explanation for high probability of use by foraging California Spotted
3985 Owls of forest patches that experienced high severity burns was increased prey promulgated by
3986 enhanced habitat conditions, including increased shrub and herbaceous cover and number of snags, and
3987 provided the following discussion on the importance of snags to Spotted Owl prey:

3988 “Snags provide shelters for prey species like woodrats and flying squirrels. In the southern Sierra
3989 Nevada, dusky-footed woodrat nests are common where shrubs encircle rock outcrops or snags
3990 (Lawrence 1966). Bushy-tailed woodrat (*N. cinerea*) densities in dry forests of eastern
3991 Washington, USA, were strongly correlated with arboreal and terrestrial cover in the form of
3992 large snags, mistletoe, and large soft logs (Lehmkuhl et al. 2006). Northern flying squirrel
3993 population densities in Oregon, USA, were correlated with the occurrence of suitable nesting
3994 cavities in trees and early decay-stage snags with diameters >50 cm (Volz 1986).”

3995 Lee et al. (2012) argued that snags play an important role in suitable California Spotted Owl habitat in
3996 burned areas. This was based on observations that occupancy decreased when ≥ 20 ha of mature conifer
3997 forest was logged within a 400-ha circle surrounding a California Spotted Owl site (Seamans and
3998 Gutiérrez 2007), whereas when an average of 32% of suitable habitat within a 400-ha circle burned at
3999 high severity no negative effect on occupancy is observed. In southern Oregon, Clark et al. (2013)
4000 modeled the effects of fire severity, salvage logging, and pre-fire habitat characteristics on occupancy by
4001 Northern Spotted Owls. They found that extinction probabilities increased as the combined area of pre-
4002 fire harvest, high-severity burn, or salvage logging increased, resulting in reduced occupancy of nesting
4003 territories by Northern Spotted Owls; however, they were unable to distinguish the effect of salvage
4004 logging from the other effects (i.e. these factors collectively contributed to declines in occupancy).
4005 Observational studies and occupancy modeling conducted to date suggest that post-fire landscapes that
4006 are salvage logged experience declines in Spotted Owl occupancy. However, other factors such as initial
4007 habitat conditions (e.g., area of pre-fire harvest), the amount and distribution of high-severity fire,
4008 regional differences in forest composition and fire history, and differential subspecies response may also
4009 influence occupancy. Based on results to date that suggest an impact of salvage logging, Bond et al.

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(2009) recommended that burned forests within 1.5 km of nests or roosts of California Spotted Owls not be salvage logged and Clark et al. recommended restricting salvage logging after fires within 2.2 km of Spotted Owl territories in the range of the Northern Spotted Owl in southern Oregon.

Fire Regime in the Northern Spotted Owl Range

When the USFWS subdivided the range of the Northern Spotted Owl into 12 physiographic provinces, information on fire disturbance regimes was used to inform boundaries (USFWS 1992). Efforts to map the fire-prone portion of the Northern Spotted Owl range since then have generally followed physiographic province boundaries, with the drier provinces of the eastern and California cascades and the Oregon and California Klamath provinces generally considered more fire-prone (e.g., see Rapp 2005, Spies et al. 2006, and Healey et al. 2008). As part of an evaluation of the NWFP, a recent effort to model fire-prone areas used fire history and environmental predictor variables to map the likelihood of large wildfire occurrence throughout the range (Davis et al. 2011). Although this approach did not use existing physiographic province boundaries or other lines used to delineate fire-regimes across the Northern Spotted Owl range to inform the model, results are generally similar to previous descriptions based on broad geographic regions (Figure 22(a)). See Davis et al. (2011) for discussion and potential explanation of differences between model results and previous predictions of fire-prone regions in the eastern and western Oregon Cascades.

Regardless of methodology used, all attempts to map fire-prone areas consistently include large portions of the Northern Spotted Owl range in California, with much of the California Klamath and California Cascades highly prone to fire disturbance. By overlaying the modeling results for fire-prone areas with the Northern Spotted Owl habitat suitability map, Davis et al. (2011) showed that the physiographic province with the most owl nesting and roosting habitat in fire-prone landscapes is the California Klamath Province. This is evident when looking at actual fire history from 1950 to 2013 (Figure 22(b)). Over the last several decades, large acreage fires have been prevalent on the landscape within the Klamath Province.

Within the fire-prone regions of California, fire regimes vary depending on a number of factors, with broad differences noted between the mixed conifer/mixed hardwood forests characteristic of the Klamath Province and the ponderosa pine forests that dominate some portions of the Cascade Province and eastern Klamath Province. The following discussion of historical and current fire regimes in California focuses on these two provinces, as these are the two regions where fire is most likely to have an impact on the Northern Spotted Owl.

Historical Fire Regime in the Klamath Province

As described in the Habitat section of this report, the Klamath Province is an area with extremely high floristic diversity and heterogeneity. This diversity arises from complex patterns in topography, soils, and climate throughout the region, which results in complex vegetation and contributes to a diverse fire regime. The natural fire regime acts in a positive feedback manner to contribute to vegetation heterogeneity and diversity (Odion et al. 2004, Skinner et al. 2006). The dominant conifer species across

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most of the low and mid-elevations in the Klamath Province is the Douglas-fir, and depending on local conditions a wide variety of conifer species may co-occur with this dominant species. At higher elevations, the dominant conifer grades into white fir, and at the highest elevations, a diverse set of subalpine conifer species can occur. Low and mid elevations are characterized by an equally diverse set of hardwood species that form lower canopy layers of mixed conifer hardwood forests and can also occur as pure stands. This occurrence of diverse hardwoods in coniferous forests of the Klamath region may reduce fire severity, and following fire may lead to more rapid recovery by sprouting (Odion et al. 2004, Spies et al. 2006). In drier eastern portions of the Klamath Province, ponderosa pine can be the dominant or co-dominant conifer. Because of the greater extent of ponderosa pine-dominated forests in the California Cascade Province, this forest type is discussed below.

Throughout the Klamath Mountains in the presettlement period most forest stands experienced at least several fires each century, suggesting a mixed fire regime of frequent low- to moderate-intensity fires (Skinner et al. 2006), with low-severity fire composing the largest portion of burned area, and high-severity fire the smallest portion (Agee 1993). Low-severity fire has been defined as those which kill less than 20% of the basal area; high-severity fire causes high tree mortality, with mortality of 70% and above used to define high-severity burns (Agee 1993, Hessburg et al. 2005). Under stable atmospheric conditions, current fires tend to follow a mixed fire regime similar to historical patterns (Taylor and Skinner 1998, Odion et al. 2004). Variation within the mixed-severity fires of the Klamath region has been strongly influenced by topography in both the presettlement and contemporary periods (Taylor and Skinner 1998). As described by Skinner et al. (2006),

“Generally, the upper third of slopes and the ridgetops, especially on south- and west-facing aspects, experience the highest proportion of high-severity burn...The lower third of slopes and north- and east-facing aspects experience mainly low-severity fires. Thus, more extensive stands of multi-aged conifers with higher densities of old trees are found in these lower slope positions. Middle slope positions are intermediate between lower and upper slopes in severity pattern.”

This topographically-controlled fire regime is the most widespread regime in the Klamath Mountains and is controlled by greater heating and drying on certain portions of mountain slopes and climatic variables in deep canyons (Skinner et al. 2006). Temperature inversions that often occur while fires are burning enhance this topographic pattern of fire intensity (Skinner et al. 2006). Historical fires were patchy and relatively small, although fires of up to several thousand acres were relatively common, and the majority of burned areas experienced low and moderate severity fire (Spies et al. 2006). The frequent occurrence of mixed-severity fires created a diverse landscape of older forest with variable openings of younger forest and nonforested areas, with the relative composition of these forest types varying depending on slope position.

Historical Fire Regime in the Cascades Province

South of the latitude of Mt. Shasta in the California Cascades, the vegetation composition and species dominance of lower and mid-montane forests is similar to that in the northern Sierra Nevada, and upper montane forests are more similar to the Klamath Mountains (Skinner and Taylor 2006). Conifer forests

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dominate the mid-montane zone on both sides of the Cascade Range and are intermixed with woodlands and shrublands. On the west side of the Cascades, mixed-species conifer forests dominate with any of six conifer species co-occurring or sharing dominance (Skinner and Taylor 2006). A subcanopy of mixed hardwoods may occur beneath the conifer canopy. Extensive areas on the east side of the Cascade Range are dominated by either ponderosa pine or Jeffrey pine (collectively referred to as yellow pine; Skinner and Taylor 2006). These forests are less complex than those on the west side with fewer co-occurring species of conifer and with relatively poor-developed understory historically. Accordingly, yellow pine-dominated forests had a distinct, more uniform fire regime.

Forest species composition and structure in the different portions of the Cascades Province is related to fire regime, with areas of mixed-severity fire regimes that occur in the Klamath and portions of the Cascades frequently supporting multi-storied old growth and the drier forests further east (dominated by yellow pine) experiencing more frequent, low-severity burns and decreased diversity (Spies et al. 2006). As in the Klamath Mountains, fire-severity in the California Cascades is associated with topographic position with the high-severity portion of burns more likely to occur on upper slopes and the low-severity burns occurring predominately on lower slopes. This pattern is less pronounced in the Cascades than in the more extreme terrain of the Klamath Mountains (Skinner and Taylor 2006). As in the Klamath region, in regions of the Cascades where fire regime is influenced by topography multi-aged and multi-sized forests are concentrated on the lower slopes and more even-aged stands that develop after high-severity burns mostly occurred on upper slopes (Skinner and Taylor 2006).

The portion of the Northern Spotted Owl range which is dominated by ponderosa pine is relatively uncommon and is distributed in a narrow band on the east side of the Cascades and in limited areas in southwestern Oregon and northern California (Spies et al. 2006). Jeffrey-pine-dominated forests occupy the lower elevations on south-, east-, and west-facing slopes in eastside environments (Skinner and Taylor 2006). These forests occur in the driest portions of the northern spotted owl range. Ponderosa and Jeffrey pine dominated forests have a distinctly different structure and historical fire regime in comparison to the mixed conifer forests of the rest of the Klamath and Cascade provinces. Historically, frequent low-severity burns resulted in low and variable tree densities, with low, patchy developed understory, and reduced fuel loads (Hessburg et al. 2005). Frequent burns favored fire-tolerant tree species such as ponderosa pine and maintained fire-tolerant forests by elevating tree crowns and consuming many small and medium sized trees (Hessburg et al. 2005). The forest structure and composition in these yellow pine forests that resulted from frequent fires reinforced the occurrence of low-severity fires by limiting the conditions that could support high severity fires (Hessburg et al. 2005). Historical open yellow pine forests would not have provided all necessary habitat conditions for the Northern Spotted Owl, but local areas of high density and complex structure likely provided requirements for nesting and roosting (Davis et al. 2011) among a landscape of mixed forest types and nonforest areas.

Recent Changes in Fire Regimes and Possible Causes

Multiple potential causes have been implicated in increasing fire activity over the last several decades. The success of fire suppression and exclusion has indirectly advanced secondary succession in forests

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and changed forest composition by increasing tree density, decreasing prevalence of fire-tolerant tree species (e.g., ponderosa pine and Jeffrey pine), and contributing to homogenization of forest structure. In some cases, timber harvest has directly advanced secondary succession through the selective removal of the largest trees (Hessburg et al. 2005). Post-harvest tree plantations have created homogeneous forests dominated by even-aged, smaller-diameter trees that in some cases are less resistance to fire. In addition, climate variables, including temperature and precipitation, have produced conditions that promote increased amounts of fire activity.

Beginning in the early 1900s in accessible areas and in the mid-1900s in remote areas, fire suppression caused a dramatic decline in fire occurrence in the Klamath province (Skinner et al. 2006). The result was a series of decades, beginning in the early 1900s, with dramatically reduced fire extent over most of the Klamath region (Taylor and Skinner 1998, 2003; see Figure 23 for example). During this period the fire rotation (time required to burn an area equal to a defined area of the landscape) increased to an estimated 974 years in the early 1980s (Miller et al. 2012) compared to a historical estimate for fire rotation of only 20 years (Taylor and Skinner 2003). In the Cascade Province the fire suppression period began in the early 1900s. The gentler slopes of the Cascade Province, relative to the Klamath region, lead to successful fire suppression efforts. This success resulted in a dramatic change in fire frequency from high frequency low-severity fires to a period of minimal fire occurrence in the California Cascades.

Following several decades of reduced extent and frequency of fire as a result of fire suppression efforts, the average fire size has increased in recent decades (beginning in the 1980s) across the western United States (Schwind 2008, Westerling et al. 2006), including the area comprising the Northern Spotted Owl range in California (Odion et al. 2004, Miller et al. 2012). The area burned annually within the entire range of the Northern Spotted Owl (Davis et al. 2011) and within the California portion of the range (Miller et al. 2012) also increased dramatically during this time and the regional fire rotation fell to 95 years by 2008 (from a high of 974 years in the early 1980s). As noted in Figure 24, the years between 1970 and 2009 with the most area burned per year in the California portion of the Northern Spotted Owl range have all occurred since 1987 (Davis et al. 2011, Miller et al. 2012). Mixed-species forests on the west side of the California Cascades have changed with the success of fire suppression, with forest density increasing and species composition shifting toward fire-sensitive white fir (Norman and Taylor 2002, Skinner and Taylor 2006). Although the Cascades portion of the Northern Spotted Owl range in California has not experienced the number or extent of uncharacteristically large fires that have occurred in the Klamath province, in recent years several large fires have burned in the eastern Cascades of Oregon and Washington and in the southern portion of the California Cascades. The gentler topography of the Cascades is more conducive to extensive fires than the Klamath region (Norman and Taylor 2003, Skinner and Taylor 2006); where forests have developed high densities of young trees due to fire suppression, fires that escape fire suppression efforts can become large and burn at high-severity (Skinner and Taylor 2006).

Although there is evidence that the increase in fire size in recent years has corresponded with an increase in fire severity in the western U.S., including the Sierra Nevada (Hessburg et al. 2005, Schwind 2008, Miller et al. 2009), trends in burn severity have been less conclusive than trends in fire size and total area burned (Schwind 2008). There is evidence from both the Klamath and Cascade provinces of

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California that the proportion of fire-severities in recent mixed-severity fires has been consistent with historical patterns, or that change has only been evident in most recent years (Odion et al. 2004, Hanson et al. 2009, Miller et al. 2012). There is, however, considerable evidence that conservation and management of present-day western dry forests is not consistent with the modern pattern of uncharacteristically large and high-severity fires (Fule et al. 2014, Spies, et al 2010b).

Some researchers have challenged the common perception that fire suppression and fuel build-up is the main cause of increased fire activity. In their study of large fires in the Klamath Mountains, Odion et al. (2004) evaluated fire history from 1977 to 2002 and concluded that fuel build-up in the absence of fire did not occur, and instead fuel that is receptive to combustion may decrease in the long absence of fire in the study area. These authors also evaluated patterns of burn severity in a nearly 100,000-ha fire that burned in the Klamath Mountains in 1987 to test the effect of fire history, past timber management, and vegetation structure on the extent and severity of current fire. Odion et al. (2004) found that multi-aged, closed forests generally burned at low severity, even where fire suppression efforts had limited fires over the previous decades. The same study found that areas with a history of high-severity fire and areas with large amounts of even-aged tree plantations experienced elevated amounts of high-severity fire. These findings are counter to the common assumption that increased extent of high density forests will lead to increased occurrence of high-severity fire. The additional findings suggests that the historical pattern of mixed-fire regime in the Klamath continues to drive patterns of at least some contemporary fires and can act to maintain diverse, heterogeneous forests (Odion et al. 2004).

Miller et al. (2012) conducted a broad assessment of patterns in the extent of high-severity fire in four national forests of northwestern California. Their study covered all fires larger than 100 acres during the years 1910 to 2008 in a 5.8 million acre area including the northern California Coast Range and the Klamath Mountains, as well as a portion of the southern Cascade Range. This study area covers most of the range of the Northern Spotted Owl on federal land in California. Although the authors observed significant increases in both fire size and total annual area burned from 1910 to 2008, they found no temporal trend in the percentage of high-severity fire in recent years.

Despite the findings of Odion et al. (2004) and Miller et al. (2012), at least one recent fire, the Biscuit Fire of 2002, has occurred in the Klamath province that was not only large but was of uncharacteristic high-severity (Skinner et al. 2006). The Biscuit Fire burned about 500,000 acres in southern Oregon and northern California. Almost 224,000 acres (49%) burned at high severity, with 75-100% canopy tree mortality, and an additional 14% of the burn area experienced 50-75% mortality (USFS 2003). This large, relatively high-severity burn was inconsistent with historical burn patterns and was associated with weather conditions that are conducive to fire (i.e., high winds and low humidity). Conversely, in the years when the most area has burned in the Klamath province of California since the 1980s, fires have primarily been caused by region-wide lightning events that strain fire suppression resources and that are associated with more moderate meteorological conditions. Overall fire severities were relatively low in these years due to the long duration of fires, weather conditions, and strong inversion events (Miller et al. 2012).

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Steel et al. (2015) presented evidence that the response of fire regime to past fire suppression varies with forest type and the degree to which fire in an ecosystem is fuel-limited or climate-limited. Forests with fire regimes that are more fuel-limited (e.g., yellow pine forests and mixed conifer forests found in much of the interior portion of the Northern Spotted Owl range in California) should experience increases in fire severity following periods of fire suppression, whereas forests with fire regimes that have been historically climate-limited (e.g., redwood forests) would be less altered by a history of suppression. Using data on fire severity for 660 fires that occurred on USFS land in California between 1984 and 2011, Steel et al. (2015) showed that the proportion of fires burning at high severity has increased for fuel-limited forest types. This increase in severity was correlated to indicators of fire suppression for much of California; however, the Klamath bioregion did not show this relationship. This suggests that fire severity, or at least the occurrence of high severity fire in the Klamath bioregion may be more limited by climate than by fuel loads. This may explain inconsistent observations of fire severity trends for the Klamath region, with measured proportions of high intensity fire varying on a case-by-case basis, depending on climatic conditions during the fire.

Where increases in fire size or severity have been observed in recent years in forests of the western United States, it has often been attributed to increased densities of fuels and development of ladder fuels as a consequence of fire suppression. Fire suppression and exclusion in ponderosa pine forests has been successful at reducing the frequency of fire which allowed for the development of shade-tolerant trees and understory vegetation in the previously open forests, and resulted in an increase in stand density (Taylor 2000). Resource-stressed stands are more susceptible to insects and disease which results in an increase in weakened or dead trees and heavy fuel loadings (Hessburg et al. 2005, Davis et al. 2011). This has led to fuel characteristics in ponderosa pine forests that can support larger and more severe wildfires (Hessburg et al. 2005). Large, severe fires in the dry eastern Cascades of Oregon and Washington have occurred in recent years (Davis et al. 2011), and the potential remains for the loss of large amounts of nesting and roosting habitat.

Past management practices that have established more homogeneous even-aged forests (e.g., fire suppression, livestock grazing, and timber harvest practices) may provide forest conditions that are conducive to high-severity fires in forests with fire regimes that were historically fuel-limited. Repeated selection cutting of the largest trees had the effect of advancing secondary succession, resulting in younger forests with higher density, fire-intolerant trees (Hessburg et al. 2005). Recent large, high-severity fires and timber harvest practices have expanded the amount of even-aged plantations, hardwood stands, and shrublands (Skinner et al. 2006). Prior to fire suppression, the forest landscape in the Klamath Mountains contained stands of even-aged forests, but they do not appear to have occupied extensive areas (Taylor and Skinner 1998, 2003, Skinner et al. 2006). Odion et al. (2004) reported that plantations occur in one-third of the roaded landscape in their large fire study area in 1987. Extensive areas of young even-aged forests that have resulted from a combination of past fire and past timber harvest practices may amplify conditions for repeated high-severity fires compared to heterogeneous forests that were created by historical patterns of mixed-severity fires (Spies et al. 2006). A positive feedback resulting from past timber management and fire suppression practices, existence of increased even-aged stands in the forest matrix, and future high-severity fire has the potential to support a new

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4245 forest matrix with stable or increasing amounts of even-aged forest and decreased heterogeneity
4246 (Skinner et al. 2006).

4247 Several studies have determined a strong link between changes in fire extent, severity and season, with
4248 low precipitation and high temperatures. In addition to land-use history over the last century, climate
4249 variables (e.g., precipitation, temperature) have been evaluated as potential causes of recent increases
4250 in large wildfires. There is an important distinction between these two potential causes. Changes in
4251 forests brought about by land-use history may be reversible through management actions, such as
4252 forest thinning and prescribed fire, while reversing trends in climate warming are unlikely in the near
4253 future (Westerling et al. 2006, Littell et al. 2009). Littell et al. (2009) found that in areas with low fuel
4254 loads the impacts could be lessened through fuel reduction prescriptions, however in areas that are
4255 experiencing low precipitation, this may prove less useful).

4256 Under various climate change scenarios (as discussed in the Climate Change section of this report), fire
4257 seasons have been predicted to be longer and fire sizes larger (McKenzie et al. 2004, Westerling and
4258 Bryant 2008, Littell et al. 2009, Miller et al. 2009, Westerling et al. 2011). For example, McKenzie et al.
4259 (2004) found that extreme fire weather (e.g., hot dry summers) in western America will influence the
4260 severity and the total area burned, with the duration of the fire season lengthened with more fires
4261 occurring early and later in the typical fire season. Westerling et al. (2006) found that periods with large
4262 fire occurrences corresponded with a shift toward warm springs and longer summer dry seasons, and
4263 suggested that both land use and climate have contributed to increased fire risk, but that broad-scale
4264 increases across the western U.S. were driven primarily by recent trends in climate.

4265 Compared to pre-European settlement, Miller et al. (2009) found that high severity fires in low- to mid-
4266 elevation forests are increasing of California and western Nevada. Miller et al. (2009) suggests that snow
4267 water deficits, earlier snowmelt, lengthening of the fire season, worsening drought conditions, low fuel
4268 moisture, and increase of forest fuel availability all play a role in how forests are in a position to burn
4269 more often and at higher severity. In this study, types of forested land most impacted by high severity
4270 fires include those on National Forest land, those experiencing high resource extraction and rapid
4271 human population growth, and those supporting old growth dependent species (Miller et al. 2009).

4272 Another study in the western United States supported theory that climate is a driving factor influencing
4273 fire extent in the 20th century, and fire regimes will vary dependent on fuel energy and water deficits
4274 (Littell et al. 2009). Low precipitation and high evapotranspiration in mountainous ecoprovinces of the
4275 western United States lead to low fuel moisture conditions; thus, creating a system at higher risk to
4276 combustion and fire spreading (Littell et al. 2009). Similar to Miller et al. (2009) findings, Littell et al.
4277 (2009) suggests low precipitation, warmer winters, reduced snowpack and drought effects lead to
4278 increases of forested area burned.

4279 With future climate change, the continued occurrence of large, uncharacteristically severe fires may
4280 become increasingly common. These changes may in turn impact the habitat, distribution and
4281 abundance of sensitive species such as the Northern Spotted Owl.

4282 Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat

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4283
4284 Variation in fire severity has an important influence on forest structural diversity because low-severity
4285 fires kill few trees while high-severity fires may kill all trees in a stand (Taylor and Skinner 2003). High-
4286 severity fires tend to result in even-aged stands while lower severity fires result in forests with multiple
4287 age classes. In much of California, the Northern Spotted Owl evolved in a landscape of frequent, mixed-
4288 severity fire, with most burns occurring at low severity and a relatively small amount of burns occurring
4289 at high severity. In the drier portion of the Northern Spotted Owl range, the species is likely adapted to
4290 the heterogeneous landscape resulting from regular, mixed-severity fire. Prior to fire suppression, the
4291 frequent occurrence of mixed-severity fires in large portions of the Klamath and Cascade ranges, along
4292 with the resulting complex landscape (e.g., older forests with openings of other forest types intermixed
4293 with nonforested areas) was prominent throughout the region. The historical mixed fire regime in the
4294 Klamath region may have benefited Northern Spotted Owl habitat by maintaining areas of older forests
4295 with dense canopies and complex structure, while also providing a heterogeneous landscape composed
4296 of multiple forest ages and structure. This pattern could have supported high quality habitat mosaics of
4297 nesting and roosting habitat and diverse foraging habitat which lead to high survival and reproductive
4298 success (Franklin et al. 2000).

4299 Current fire regime and its potential to impact Northern Spotted Owl habitat depends on a number of
4300 factors including: fire management history, logging history, forest type, historical fire regime, weather
4301 patterns and climate change. Additionally, observed impact to Northern Spotted Owl is likely
4302 complicated by occurrence of post-fire salvage logging. Although forest heterogeneity has decreased
4303 with recent management practices, the forests of the Klamath Mountains continue to provide habitat
4304 for Northern Spotted Owl. More information is needed on the effect of historical fire suppression and
4305 current fire regimes on owl habitat, especially on the quality of habitat as assessed through
4306 demographic rates at individual owl territories. Most fires in the Klamath region continue to burn under
4307 historical mixed regimes that can contribute to a heterogeneous forest landscape. However, recent
4308 large fires are cause for concern for the future stability of forest conditions in the region, especially
4309 considering the higher percentage experiencing high-severity burns. Large amounts of Northern Spotted
4310 Owl nesting and roosting habitat has been lost to wildfire since implementation of the NWFP, with the
4311 majority being lost in a few very large fires (e.g., the Biscuit Fire of 2002) (Davis et al. 2011). Fires have
4312 been more frequent during dry years (Cook et al. 1996) and extreme weather events influence the
4313 occurrence of large, landscape-scale fires (Miller and Urban 2000). Wildfire has been the leading cause
4314 of nesting and roosting habitat loss on federal lands in recent decades; if large fires continue to occur in
4315 the future, much more habitat may be lost.

4316 Historical fire suppression and exclusion in ponderosa pine forests in the Cascades was successful at
4317 reducing the frequency of fire which allowed for the development of shade-tolerant trees and
4318 understory vegetation in the previously open forests, and resulted in an increase in stand density (Taylor
4319 2000). This may have improved nesting and roosting habitat conditions for Northern Spotted Owls in
4320 these forests compared to the pre-suppression period. However, high densities of younger trees as a
4321 result of fire suppression and timber management practices have created conditions with potential for
4322 stand-replacement fires in ponderosa pine forests. Ideally a landscape-scale management strategy for

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these forests would retain large, dense patches of forests embedded in a matrix with reduced stand densities to limit the potential for stand-replacement fire and competitive pressure on old trees (Thomas et al. 2006).

With the complexity of fire regimes in the state, the sometimes equivocal effects on Northern Spotted Owls, the uncertain contribution of fuel build-up, and climate influences on future fire frequency and severity, there has been disagreement on the level of risk that fire poses in the dry portions of the Northern Spotted Owl range. Hanson et al. (2009) reported that the risk of fire to Northern Spotted Owl habitat in the dry provinces had been overestimated in the 2008 Recovery Plan, which included ongoing loss of habitat as a result of timber harvest and fire as threats to the Spotted Owl (USFWS 2008a). This claim of overestimation was made based on calculated rates of old-forest recruitment exceeding rates of high severity fire in old-forests (Hanson et al. 2009). Spies et al. (2010) criticized the findings of Hanson et al. (2009), stating that an incorrect threshold was used to estimate extent of high severity fire and that an incorrect depiction of error was used to support selection of the threshold. Spies et al. (2010) also disagreed with the methodology used by Hanson et al. (2009) to estimate the rate of recruitment of old forests.

This debate on the risk of fire to Northern Spotted Owl habitat has important management implications. If recent and projected changes in fire size or severity continue to remove large amounts of nesting and roosting habitat, fuel treatments (e.g., thinning and prescribed fire) to reduce fire risk may have long-term benefits to owls by encouraging the development and maintenance of older forest patches while limiting the risk of stand-replacing fires. However, if recent large high severity fires are an anomaly and recruitment of old forest outpaces losses to high severity fire, natural processes can be incorporated into management plans to shape Spotted Owl habitat on the dry province landscape. Hanson et al. (2010) recommended small-scale experiments to study owl response to fuel treatments rather than large-scale implementation. Risks are not likely to be uniform across the range, with ponderosa pine forests likely having a different response to past management than mixed-conifer forests of the Klamath, for example. The 2011 Revised Recovery Plan recommends formation of working groups to inform management in both the Klamath and dry Cascade provinces (USFWS 2011a).

Climate Change

According to global and regional climate scenarios, many species will be required to adapt to changes in temperature, precipitation, forest structure, etc., or face eminent declines or extirpation. The degree of threat varies based on species and region. Climate change scenarios have been modeled across the range of the Northern Spotted Owl, including in California. Several studies have been conducted to assess the threat to Northern Spotted Owl specifically.

Climate Change Projection Modeling

In California, a multitude of climate change studies have been conducted. As noted by Pierce et al. (2012), a common theme among the California-specific studies indicates temperature showing a consistent positive trend, but changes in precipitation vary. Generally, most studies agree that California

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4360 will retain its Mediterranean climate of cool/wet winters and hot/dry summers, yet the degree of
4361 wetness/dryness will be amplified (Lenihan et al. 2003, Cayan et al. 2012).

4362 The projected climate model simulations from Cayan et al. (2012) exhibit warming over California, with a
4363 mid-century rise of approximately 1°C to 3°C (1.8°F to 5.4°F), and 2°C to 5°C (3.6°F to 9°F) rise by end-of-
4364 twenty-first century. Pierce et al. (2012) showed an average yearly increase in temperature over
4365 California of 2.4°C by the 2060s, with coastal areas showing less warming (1.9°C) than interior areas
4366 (2.6°C). Westerling and Bryant (2008) predicted an average increase of 4.3°C in California by 2070–2099.
4367 Seasonally, the summer and fall months exhibit greater warming than winter and spring months (Cayan
4368 et al. 2012, Pierce et al. 2012), with the degree of warming increasing as one moves from the coast to
4369 the interior of the state (Cayan et al. 2012). Extreme temperature events (i.e., frequency of extreme hot
4370 days) will become more common place and may take place earlier in the season (Cayan et al. 2012).

4371 Climate projection modeling conducted by Cayan et al. (2012) show a high degree of variability between
4372 month-to-month and year-to-year precipitation with slight drying tendencies in some areas of California,
4373 which may suggest that California will remain at risk to drought and flooding events, with more
4374 prominent changes in the southern portion of the state ~~that~~ than the northern portion. Seasonal
4375 changes in precipitation included a somewhat contracted wet season, with less precipitation during late
4376 winter and spring than during the core winter months (Cayan et al. 2012). Pierce et al. (2012) found
4377 precipitation decreased overall in the southern portion of California (<10%) by the 2060s, but remained
4378 unchanged from historical levels in the northern portion of the state. Seasonally, winters in the
4379 northern portion of the state were wetter and offset by drier conditions the rest of the year by the
4380 2060s, while the southern part of the state showed moderate decreases in fall, winter, and spring but
4381 stronger increases in summer (Pierce et al. 2012).

4382 Dalton et al. (2013) summarizes climate projection models for the Coastal, Cascade and Rocky Mountain
4383 ranges of Washington, Oregon and Idaho (e.g., Northwest). This paper indicates that the region showed
4384 an overall increase of temperature year-round (warming of at least 0.5 °C (0.9 °F) in every season), but
4385 more prominent warming during summer months. Modeling showed mixed results for annual
4386 precipitation, indicating little change from present (models ranged from –4.7% to +13.5%). Seasonally,
4387 most models showed a decrease in precipitation during summer months and increased precipitation
4388 during the other seasons (the largest projected change of about –30%). Dalton et al. (2013) climate
4389 models are in agreement that heat extremes will increase and cold extremes will decrease. Along the
4390 Northwest coast, sea level rise was projected to rise 4 to 56 in (9–143 cm) by 2100, with significant local
4391 variations.

4392 *Climate Change Impacts to Forests*

4393 In the Northwest and in California, changes in precipitation and temperature may impact forest
4394 distribution, growth, and structure (Lenihan et al. 2003, Dalton et al. 2013, Vose et al. 2012, McIntyre et
4395 al. 2015). Most climate projection models indicate upward elevational shift and a northward latitudinal
4396 shift in forest habitats (Vose et al. 2012). In climate projection scenarios specific to California, Lenihan et
4397 al. (2003) noted the most notable response to increase temperature was a shift from conifer-dominated

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4398 forests to mixed conifer-hardwood forests in the northern half of the state (e.g., the replacement of
4399 Douglas fir-white fir forest by Douglas fir-tan oak forest in the northwest) and an expansion of conifer
4400 forests into the northeast portion of the state (e.g., Modoc Plateau) by the 21st century. McIntyre et al.
4401 (2015) found similar results when comparing historic forest survey data (1930s) with recent surveys
4402 (2000s) to elucidate forest structure and composition shifts over time within the entire latitudinal extent
4403 of forests in California. This study found that today's forests are exhibiting an increase dominance of
4404 oaks (*Quercus*) at the expense of pines (*Pinus*). McIntyre et al. (2015) also found that across the
4405 120,000km² study area, large trees declined by 50% with a 19% decline in average basal area and
4406 associated biomass since the early 1900s. Understanding the shifts in structure and species composition
4407 is complex, but McIntyre et al. (2015) partially attributed these shifts to water deficits within California
4408 forests (e.g., drought), while acknowledging other contributing factors such as logging and fire
4409 suppression (McIntyre et al. 2015). Conifer-dominated forests (e.g., redwood and closed-cone pine
4410 forests) along the north-central coast of California (e.g., Crescent City south to Monterey) were
4411 projected to advance, resulting in redwood forests shifting inland into Douglas-fir-tan oak forests
4412 (Lenihan et al. 2003). Dalton et al. (2012) found that Douglas-fir forests in the Northwest may
4413 experience substantial declines through the 21st century. Tree productivity along California's north-
4414 central coastal and at high elevation forests was shown to increase in response to increased growing
4415 season temperatures; however, increases in productivity along the coast would only be seen if there
4416 was a persistence of coastal summer fog (Lenihan et al. 2003). Lenihan et al. (2003) suggests that if
4417 summer fog were to decrease in concert with increased temperatures, productivity of redwood forests
4418 along the coast would suffer reductions, or worse, would be eliminated entirely.

4419 Vulnerability to disturbance, such as wildfire, disease and insect outbreaks, is expected to increase in
4420 most forests in the Northwest and may change forest composition and structure depending on changes
4421 to climate (Dalton et al. 2012, Vose et al. 2012). According to Davis et al. (2011), one of the objectives of
4422 US Forest Service is to develop projections for wildfire regimes and habitat shifts due to changing
4423 climate and increased threats from wildfire, disease and insect outbreaks. Vose et al. (2012) effectively
4424 summarizes the nationwide effects of climate driven disturbance as follows:

- 4425 • Wildfire will increase causing a doubling of area burned by mid-21st century
- 4426 • Insect infestations (e.g., bark beetle in the western US) will expand
- 4427 • Invasive species will likely become more widespread, and especially in areas with increased
- 4428 disturbance and in dry forests
- 4429 • Increased flooding, erosion and sediment transport caused by increase precipitation, area of
- 4430 large burned areas, and rain-snow ratios
- 4431 • Increases in drought occurrences, exacerbating other disturbances (e.g., fire, insect outbreaks,
- 4432 invasive species), which will lead to higher tree mortality, decreased regeneration in some tree
- 4433 species, and alteration of tree species composition and structure

4434 Climate modeling studies agree that forest wildfire occurrence and severity will increase due to warmer
4435 spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and
4436 longer drier summers (Swetnam 1993, National Assessment Synthesis Team 2000, Houghten et al. 2001,

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Lenihan et al. 2003, Westerling et al. 2006, Westerling and Bryant 2008, McKenzie and Littell 2011, Vose et al. 2012). Spracklen et al. (2009) projected that forests of the Pacific Northwest forests will experience increases in mean annual area burned, with a projected increase of 175% by 2050 compared to areas burned between 1996 and 2005. This increase will likely negatively impact old-growth forests and the species that inhabit them (Dalton et al. 2012, Vose et al. 2012). By evaluating fire history and climatic data in forested areas across the western United States over a 34-year period, Westerling et al. (2006) tested the contributions of land use and climate conditions on occurrence of large fires. Over this study period, the frequency and size of wildfires showed a marked increase in the mid-1980s; a large portion of this increase occurred in the range of the Spotted Owl in California (Sierra Nevada, southern Cascades, and Coast Ranges of northern California). The period of increase in large fire occurrence corresponded with a shift toward warm springs and longer summer dry seasons (Westerling et al. 2006). The authors concluded that both land use and climate have contributed to increased fire risk, but that broad-scale increases across the western U.S. were driven primarily by recent trends in climate. For California as a whole, by the end of the 21st century, risk of large fire will increase between 12 and 53 percent compared to observed fire regimes between 1980 and 1999, and for northern and southern California, large fires will increase 15 to 90 percent and -29 to 28 percent, respectively (Westerling and Bryant 2008). See the Wildfire section above for more detailed discussion on wildfire impacts to forest systems.

Climate Change Impacts to Northern Spotted Owl

Northern Spotted Owls utilize older structurally complex forests, in part, to facilitate thermoregulation and to provide protection from predators. Forest type and age within owl habitat varies by region. Coastal regions are wetter and cooler and tend to be redwood species dominant and of a younger age class, whereas inland regions are drier and warmer and tend to be mixed conifer/hardwood or Douglas-fir dominant.

Most climate projection scenarios agree that the forests in the Northern Spotted Owl's range will have wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased frequency and intensity of disturbance events. According to many climate projections, the frequency and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will increase over time. Extreme climatic variation has been linked to sudden large-scale mortality in avian populations in the past (Tompa 1971, Johnson et al. 1991, and Smith et al. 1991 as cited in Franklin et al. 2000), and the literature studying Spotted Owl response to climate supports this.

Northern Spotted Owl survival is thought linked to precipitation patterns. Olson et al. (2004) stated that survival was negatively associated with early-nesting season precipitation, and positively associated with late-nesting season precipitation. Population growth for Northern Spotted Owls range-wide (Washington, Oregon and California) was positively associated with wetter conditions during the growing season (May through October) due to more favorable conditions for prey species, but negatively associated with cold/wet winters and nesting seasons, and during hot summers on four of the six study areas (Glenn et al. 2010). Over the extent of late-successional reserve land covered by the

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4476 NWFP, Carroll (2010) predicted that winter precipitation was closely associated with a decrease in
4477 Northern Spotted Owl survival and recruitment (i.e., the entirety of the Northern Spotted Owl range in
4478 Oregon, Washington and California). Using vegetation and climate variables, model results in Carroll
4479 (2010) predicted an initial northward expansion of high quality owl habitat, followed by a contraction as
4480 climate variables intensify over time.

4481 In the Coastal and Klamath Mountains of northwestern California, Franklin et al. (2000) thoroughly
4482 examined the effects of climate on temporal and spatial variation of Northern Spotted Owl survival,
4483 reproductive output, and recruitment. In these models, climate explained most of the temporal
4484 variation in life history traits. The study suggested that the period most impacted by climate was during
4485 the spring, presumed largely due to higher energetic demands during the breeding season, as well as
4486 prey abundance and availability. Franklin et al. (2000) states, “extreme climate conditions during the
4487 early nesting period may exacerbate an energetic stress on an individual by decreasing it’s time to
4488 starvation.” However, the winter period did explain variation in recruitment, thought to be a function of
4489 reduced survival of young during their first year.

4490 In Oregon and Washington, Glenn et al. (2011) found a negative association between Northern Spotted
4491 Owl reproduction (number of young fledged) and cold wet nesting season, thought to be a function or
4492 loss of eggs or young to exposure or terminating incubation (Forsman et al. 1984). Whereas,
4493 reproduction was positively associated with late nesting season precipitation and negatively associated
4494 with warm temperatures, thought to be a function of reduced prey abundance and availability.
4495 Interestingly Glenn et al. (2011) also found that number of young fledged per year declined when
4496 precipitation in the year prior deviated from normal, and that number of young fledged per year
4497 increased following warm wet dispersal seasons. Some of these results differ from California studies
4498 such as Franklin et al. (2000), and may be a function of differing habitat, climate and targeted prey
4499 species. Regardless, the study suggests that Northern Spotted Owl reproductive success involves a
4500 complex relationship between prey populations, body condition and climate prior to and within the
4501 nesting season; a statement that, given the current literature on the species, certainly holds true for the
4502 species in California.

4503 The literature also indicates that Spotted Owls are sensitive to heat stress (Franklin et al. 2000,
4504 Weathers et al. 2001, Barrows 1981), which may be more problematic as temperatures rise over time.
4505 For the California Spotted Owl, Weathers et al. (2001) found that when temperatures reached between
4506 30 and 34°C, a relatively moderate level, owls increased behavioral heat responses (e.g., increase
4507 respiratory rate, gaping, wing drooping).

4508 As previously discussed, structural complexity (broken top trees, snags, overhead cover) is an important
4509 habitat component for Northern Spotted Owls. Structural complexity is an important factor in
4510 determining the availability of suitable nest sites. Rockweit et al. (2012) found that nest type selection
4511 played a role in Northern Spotted Owl reproductive success in California during period of inclement
4512 weather (i.e., low temperatures and high winds). Nests that were more exposed to the elements, such
4513 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at
4514 protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must

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4515 include structurally complexity to provide nesting options with proper protection. The intensity of
4516 disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or
4517 detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced
4518 when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may
4519 increase the level of structural complexity.

4520 Habitat loss and alteration due to heightened disturbance events (e.g., wildfire, disease, insect
4521 outbreaks), may also impact forest species, such as the Northern Spotted Owl, by intensifying
4522 competitive pressure from other species, such as Barred Owl (Lenihan et al. 2003, Carroll 2010).

4523 Direct mortality of Spotted Owls from wildfire will likely may increase as frequency and intensity of
4524 wildfires increases. Indirect impacts may also include an increased level of predation if there is loss of
4525 older or structurally complex forests. However, neither direct mortality nor increased predation is
4526 specifically addressed in the literature.

Comment [JEH18]: Not sure that direct mortality from fire has ever actually been documented.

4527 To better understand potential climatic impacts to Northern Spotted Owls, the Department compiled
4528 average 30-year (1980-2010) and 5-year (2010-2014) precipitation and temperature data and calculated
4529 the percent change within the owls range. Decreases in precipitation were most apparent in the
4530 southern portion of the coastal range (Marin, Sonoma and Mendocino counties), and within the interior
4531 range (Figure 25). Increases of precipitation were more limited, with increases seen in a small portion of
4532 northern Trinity County, and scattered within Humboldt and Del Norte counties. This analysis generally
4533 shows a drying trend throughout the owl's range, except in the northern portion of the coastal province
4534 and some small portion of the Klamath province.

4535 Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-
4536 August) and winter months (December-February) separately. Comparing the 30-year average with the 5-
4537 year average, temperature increases during the summer months were seen mostly within the north and
4538 northwest portions of Siskiyou County (northern portion of the Klamath and Cascade provinces), and
4539 along scattered portions of the coastal province (Figure 26). As shown in Figure 26, temperature
4540 decreases in the summer months were seen most prominently within the rest of the interior (Klamath
4541 and Cascade provinces). During the winter months, temperature increases were seen within interior
4542 (Klamath and Cascade provinces), while decreases were seen most prominently in the coastal province
4543 (Figure 27). This analysis generally shows warmer winters and cooler summers compared to normal
4544 within the interior portion of the Northern Spotted Owl range, and cooler winters and warmer summers
4545 along the coastal portion of the range.

4546 It is clear that climate change is occurring within the Northern Spotted Owl's entire range, with many
4547 climate projections forecasting steady changes in the future. Climate change studies predict future
4548 conditions that may negatively impact owls, such as wet and cold springs, more frequent and sever
4549 summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased
4550 frequency of severe wildfire events. Yet in some instances predicted future conditions, such as increased
4551 frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to
4552 the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change

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predict hotter drier conditions in some areas of the owl's range and wetter colder conditions in other areas of the range. Looking at past precipitation and temperature trends, drying trends across most of the owl's range in California coupled with warmer winters and cooler summers in the interior and cooler winters and warmer summers along the coast may play a role in both owl and prey population dynamics. More research is needed to assess the extent of these climate impacts on survival, population growth and reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of climate change outweigh the positive ones.

Barred Owl

Barred Owl Expansion and Current Status in California

Historically, Barred Owls were residents of the eastern United States and southern Canada, east of the Great Plains and south of the boreal forest, and also in disjunct regions of south-central Mexico (Mazur and James 2000). Based on genetic analysis, Barrowclough et al (2011) found the disjunct Mexican populations to be distinct from populations in the United States and Canada at the species level, and recommended they be recognized as *Strix sartorii*. Barred Owls continue to occupy their historical range, and during the past century have expanded their range to western North America.

The timing and route of the Barred Owl range expansion into western North America has been debated by the scientific community and is not resolved. An early and long-held view has been that Barred Owls expanded their range to the west via the boreal forests of Canada (Grant 1966, Hamer 1988, Houston and McGowan 1999, Holt et al. 2001). Livezey (2009a) suggested a slightly different pattern of expansion based on records for more than 12,500 Barred Owl detections from 1873 to 2008. He suggested that the expansion began via riparian forests of the Missouri, Yellowstone, and Musselshell rivers of the northern Great Plains to the forested mountains of western Montana at the end of the 19th century (Figure 28). From Montana, he suggests that Barred Owls then expanded their range in multiple directions, including to the north and then east, where they encountered Barred Owls that were expanding their range west through the boreal forests of Canada. Whether the initial range expansion was via the boreal forest of Canada or the riparian corridors of the northern Great Plains, once Barred Owls reached British Columbia in the 1940s, they continued their range expansion to the north and west across Canada to southeastern Alaska, and south through Washington, Oregon, and California (USFWS 2011a, USFWS 2013). The range of the Barred Owl now completely overlaps the range of the Northern Spotted Owl from southwest British Columbia south along the western portion of Washington, Oregon, and northern California, and also includes a significant portion of the range of the California Spotted Owl.

Barred Owls were first detected in California in 1976 (Dark et al. 1998, B. Marcot in Livezey 2009a). From then until 1996, 61 Barred Owl sites were identified in California (Dark et al. 1998). The majority of these sites (73%) were occupied by single owls. The first report of breeding in California was in 1991 (T. Hacking in Dark et al. 1998) and the first sighting in the Sierra Nevada was in 1991. The rate of detections of Barred Owls in California accelerated during the mid-1990s (Dark et al. 1998) and by 1996 Barred Owls had been detected as far south as Sonoma County in western California and Yuba County in

Comment [JEH19]: Dark et al. (1998) shows the earliest CA report as being from 1978 so only the Livezey citation seems to work here.

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the Sierra Nevada. Forsman et al. (2011, Appendix B) presented data showing that the rate of detection continued to accelerate through the 2000s. Currently, the known range of the Barred Owl in California extends along the coast south to Marin County (Jennings et al. 2011, Ellis et al. 2013) and to Tulare County in the Sierra Nevada.

The Department has processed data for 1,970³ Barred Owl occurrences in California (Figure 29), and 111 additional occurrences of Barred-Spotted Owl hybrids. Occurrences include all detections of barred owls, whether or not they were associated with a nest or territory.

Following the range expansion of Barred Owl into the Northern Spotted Owl range, hybrids of the two species have occasionally been observed. The majority of hybrids genetically sampled resulted from a cross between a female Barred Owl and a male Spotted Owl (Haig et al. 2004, Kelly and Forsman 2004). Generally second generation hybrids are difficult to distinguish from barred or Spotted Owls using field identification only and genetic samples may be the only sure way of identification (Kelly and Forsman 2004). Both first and second generation hybrids were found to be reproductively viable to some extent (Kelly and Forsman 2004). Haig et al. (2004) found that the two species DNA sequences showed a large divergence and could be separated into distinct clades with no signs of previous introgression.

Potential Mechanisms of Barred Owl Range Expansion

Factors that may have facilitated the range expansion have been debated in the literature at length. As mentioned above, two possible routes for the initial expansion from eastern North America have been suggested (i.e., riparian forests of the northern Great Plains and the boreal forest of Canada). It has been speculated that an ecological barrier existed prior to the end of the 19th century and that changes, either anthropogenic or natural, removed the barrier, and allowed for the initial westward expansion of the Barred Owl range.

The most prominent theory is that an increase in the number of trees and forested areas supported the expansion by providing suitable Barred Owl habitat where before there was none (e.g., within the Great Plains). The relatively fast Barred Owl range expansion coincides with a period of dramatic increases in wooded habitat across the northern Great Plains and the boreal forests of Canada following arrival of European settlers. Explanations for an increase in the number of trees are anthropogenic and include fire suppression, tree planting (including shelterbelts), extirpation of bison, and to a lesser extent reductions in beaver, elk and deer populations on the northern Great Plains due to market hunting (Dark

³ The 1,970 occurrences processed to date represent a subset of available data and come from 2 general sources: 1) state and private researchers, biologists and foresters from 1978-2013 and 2) the Forest Service's NRIS database with records from 1992-2011. Data omitted due to time constraints includes 1) hard copy data, 2) 2012-2013 NRIS detections and 3) NRIS detections that were within 1 mile of processed data to avoid duplicates; this data, not including duplicates, will be added in the future. An updated version of NRIS containing 2012 and 2013 detections is still needed. Additional data from the 2013 field season is also yet to be submitted. There is likely more data in holding and data from additional sources that has not been submitted.

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et al. 1998, Wright and Hayward 1998, R. Gutiérrez in Levy 2004, Livezey 2009b). Livezey (2009b) evaluated the plausibility of barriers to range expansion that have been proposed. He provided strong evidence that the northern Great Plains were largely treeless prior to the range expansion, a finding that supported a lack of habitat as a potential barrier. He also evaluated a number of anthropogenic changes (as noted above) preceding or coincident with the expansion and that are likely to have greatly increased the forest habitat in the region. Livezey concluded that the most plausible explanation for an ecological barrier that existed prior to range expansion, the removal of which coincided with range expansion, is an increase in forest habitat, first along the rivers and later in the boreal forest. Tree planting and fires suppression are obvious causes of the increase in wooded area, and the timing of these precedes the expansion of Barred Owl to the west. Huge numbers of bison destroyed small wooded areas on the Great Plains through rubbing on older trees and browsing or trampling of young trees (Livezey 2009b). The extirpation of bison precedes the increase in wooded habitat on the northern Great Plains. Elk, deer, and beaver have also been shown to have local effects on forest habitat, and may have contributed to suppression of forests in the Great Plains, especially in the limited wooded habitat along riparian corridors (Livezey 2009b).

Another theory is that increases in temperature may have improved habitat value for Barred Owls in the boreal forest (Johnson 1994, Wright and Hayward 1998, Monahan and Hijmans 2007). This theory is based on an assumption that the boreal forests of southern Canada were too cold to be tolerated by Barred Owls, and that a warming climate brought these forests into the range of temperature tolerance for the species, thereby eliminating a natural barrier to Barred Owl range expansion. Because portions of the current range of Barred Owls (e.g., northern Alberta and British Columbia, the Northwest Territories) are much colder than the forests of southern Canada, Livezey (2009b) rejected the hypothesis that a thermal barrier was preventing range expansion, but he suggests conducting additional research on the thermal tolerances of Barred Owls. Additionally, the temperature increase referenced in the literature occurred in part after the Barred Owl range expansion had begun (Johnson 1994, Monahan and Hijmans 2007), calling this mechanism of range expansion into question.

Once Barred Owls expanded across the middle of the continent, they encountered forests of the Rocky Mountains and the Pacific Northwest. Timber harvests may have facilitated the further expansion of the range by creating a mosaic of more open forest habitat that might be favored by a habitat generalist like the Barred Owl (Hamer et al. 1989, Dark et al. 1998). However, Barred Owls have become established in a variety of habitats, including mature forests that have not been harvested, challenging this as a factor in the further expansion of the range (USFWS 2013). Because Barred Owls are habitat and prey generalists (as explained below), the suggestion that they adapted to use of a novel (coniferous forest) habitat, which then allowed them to spread through the boreal forest and the forests of the west has largely been dismissed (Livezey 2009b, USFWS 2013).

Spotted Owl and Barred Owl Habitat, Prey Selection, and Home Range

Barred Owls tend to select low to high elevation areas with gentle slopes, large overstory tree with expansive crown diameter, and evergreen stands with a dense canopy, but will also nest in areas with young trees, deciduous tree species and open areas (Herter and Hicks 2000, Buchanan et al. 2004,

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Gremel 2005, Hamer et al. 2007, Jennings et al. 2011, Mazur and James 2000, Pearson and Livezey 2003, Singleton et al. 2010). Recently, Wiens et al. (2014) determined that Barred Owls selected a broad range of forest types in western Oregon, but were more strongly associated with large hardwood and conifer trees within relatively flat areas along streams. In the eastern Cascades Range in Washington, Singleton (2015) found Barred Owls used structurally diverse mixed grand fir and Douglas-fir forests during the breeding season more often than open ponderosa pine or simple-structure Douglas-fir forests, with less selection among forest types during the non-breeding season. Spotted Owls may have a stronger affinity than Barred Owls to Douglas-fir dominant forests and more abundant dwarf mistletoe infestations, an important habitat feature for nesting Spotted Owls in the Washington's eastern Cascades (Singleton 2015). Similarities between Barred Owl and Spotted Owl habitat preferences include selection of old forests with closed canopy and a high degree of structural complexity for nesting and roosting activities (Mazur et al. 2000, Singleton et al. 2010, Wiens et al. 2014, Singleton 2015). As Wiens et al (2014) points out, the similar habitat preference for older forests highlights the importance for maintaining this forest type on the landscape because a decrease in older forests will likely increase competitive pressure between the two species. Differences of habitat selection include the tendency for selection of lower elevation sites with gentle slopes (e.g., valley floors) by Barred Owls, the use of a larger variety of forest types by Barred Owls, the stronger dependence on Douglas-fir dominant forests by Spotted Owls, and more abundant mistletoe infestations by Spotted Owls. Currently, there is no indication that the two species can coexist, sharing the same habitat and prey-base, because there is little evidence that nesting habitat or prey-base can be adequately partitioned to prevent competition (Gutiérrez et al. 2007, Dugger et al. 2011, Singleton 2015). However, protecting high-quality habitat on the landscape may provide a temporary refugia for spotted owls from competitive interactions with barred owls, allowing managers and others time to evaluate competitive effects and effectiveness of control measures (USFWS 2011a).

Home range analyses show the importance of mature forests for nesting by both Barred and Spotted Owls; however, Barred Owls select other forest cover types similar to their availability whereas Spotted Owls are more tightly associated with old forests (Hamer et al. 2007, Singleton et al. 2010). Home ranges for both species have been found to be smaller in old mature forests; however, within forest types, home ranges of Spotted Owls are 3 to 4 times larger than those of Barred Owls (Hamer et al. 2007, Singleton et al. 2010, Wiens et al. 2014). In a western Oregon study, Barred Owl home range and core area use (i.e., the portion of the fixed-kernel breeding season home range in which use exceeded that expected under a null model of a uniform distribution of space-use) was 581 ha and 188 ha, respectively; whereas Northern Spotted Owl home range and core area use was much larger - 1843 ha and 305 ha, respectively (Wiens et al. 2014). In some areas of sympatry, little overlap exists between Barred and Spotted Owl home ranges, which is indicative of competitive exclusion of Spotted Owls by Barred Owls (Hamer et al. 2007, Singleton et al. 2010). However, Wiens et al. (2014) found overlap between the two species with adjacent territories in western Oregon to be 81%, with most space sharing in the foraging areas outside of the core area use.

Barred Owls are opportunistic hunters that consume a wide array of prey, including small mammals ranging from rabbits to bats, small to medium sized birds, amphibians, reptiles, fish, and invertebrates;

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however, mammals make up a majority of prey items (Hamer et al. 2001, Mazur and James 2000), making them more of a generalist than Spotted Owls in their selection of prey. Hamer et al. (2007) measured a diet overlap by biomass of 76% between Spotted and Barred Owls in a region of sympatry in the Cascades of Washington. Wiens et al. (2014) found dietary overlap by biomass between the two species to be moderate (41%) with Northern flying squirrel, woodrat and lagomorph species the primary prey for both (84% of Northern Spotted Owl diet and 49% of Barred Owl diet). Both studies suggest competition for food resources between the two species.

Prey species composition and density drive habitat selection and home range size for both owl species; however, Spotted Owls are more sensitive to fluctuations in prey abundance and availability than Barred Owls due to their more limited number of preferred prey species (Bond et al. 2013, Franklin et al. 2000, Hamer et al. 2007, Meyer et al. 1998, Thomas et al. 1990, Ward 1990, Zabel et al. 1995, Zabel et al. 2003, Wiens et al. 2014). The narrow range of prey selected by Spotted Owls contributes to the need for much larger home ranges in comparison to Barred Owls. Because Barred Owls use a much wider variety of prey, their home ranges are smaller, resulting in higher densities of Barred than Spotted Owls (Livezey et al. 2008). Barred Owls have been implicated in Western Screech-Owl declines in British Columbia (Elliot 2006), and the adverse effects of invasive Barred Owls on other species of California wildlife are unstudied (see USFWS 2013).

Impacts of Barred Owls on Spotted Owls

Data is lacking to adequately assess Barred Owl abundance in western North America. However, Northern Spotted Owl populations are declining throughout most of their range. The USFWS holds periodic workshops with Northern Spotted Owl researchers to assess population parameters, such as abundance, trend and survival (USFWS 2013). These workshops have resulted in four published and one unpublished meta-analyses since 1994 (Burnham et al. 1994, 1996, Anthony et al. 2006, and Forsman et al. 2011). These analyses show that in areas where Barred Owls are present, the decline in Northern Spotted Owl abundance has been steeper than where the Barred Owl was absent. Declines were more prevalent where Barred Owls density was greatest. In addition, analyses determined that Northern Spotted Owl adult survival declined in a majority of the study areas in Washington, Oregon, and California where Barred Owls were present, with a more gradual decline in California sites (Forsman et al. 2011). The relatively lower rate of decline in California may be attributable to the relatively more recent Barred Owl expansion into California. The presence of Barred Owls in or near Spotted Owl territories appears to be impacting the abundance, fecundity, and survival of Spotted Owls (Olson et al. 2004, Forsman et al. 2011). Wiens et al. (2014) found annual survival for Northern Spotted Owl in western Oregon lower (0.81, SE=0.05) than that of Barred Owl (0.92, SE=0.04), with a strong positive relationship on survival to old forests (>120 years) for both species. Northern Spotted Owl reproduction increased linearly with increasing distance from Barred Owl territory centers, and all Northern Spotted Owl nests failed when within 1.5 km (0.93 miles) of a Barred Owl nest (Wiens et al. 2014).

The expansion of the Barred Owl range into that of the Spotted Owl has been documented mainly through incidental detections during Spotted Owl surveys. Based on these detections, numerous

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researchers have reported that Barred Owl numbers quickly increase after a short period of slow increase once they arrive in a new area (USFWS 2013). In the Oregon Cascades, Barred Owl detections increased from one initial detection in 1979 to over 700 detections by 1998 (Kelly 2001). Barred Owls can also quickly outnumber Spotted Owls; in the Northern Cascades in Washington, Barred Owl abundance was twice that of Spotted Owls within 17 years of the first detection (Hamer et al. 1988). In the range of the Spotted Owl, the density of Barred Owls is greatest in the north, where they have been present the longest (British Columbia and Washington), and fewer detections have been made in the southern edge of the range (California) where they have been present for a shorter duration (USFWS 2013). Despite this general north-south gradient in the density of Barred Owls, Forsman et al. (2011) provide strong evidence of increasing Barred Owl populations throughout the range of the Northern Spotted Owl and California Spotted Owl.

Barred Owl presence has also been determined to be negatively associated with Spotted Owl occupancy throughout the range of the Northern Spotted Owl (Olson et al. 2005, Kroll et al. 2010, Forsman et al. 2011, Sovern et al. 2014). Studies have shown that Barred Owl presence influences whether Spotted Owls occupy a territory (Kelly 2001, Pearson and Livezey 2003, Gremel 2005, Sovern et al. 2014). In Olympic National Park, an area with historic Northern Spotted Owl territories, occupancy of Spotted Owls declined by almost 20 percent as Barred Owl presence increased by 15 percent between 1992 and 2003 (Gremel 2005). It has also been determined that Spotted Owls will move activities away from areas with Barred Owl presence even if they do not move their territory (Kelly 2001, Gremel 2005). Within the Hoopa Valley Indian Reservation (Humboldt County, California), Barred Owls were detected in over 85% of all historic Northern Spotted Owl territories between 2009 and 2014 (Higley and Mendia 2013). Northern Spotted Owl occupancy in the Hoopa study area started a steep decline in 2004, in concert with a boom in Barred Owl occupancy; and in 2013, Northern Spotted Owl occupancy was down to 0.595 while Barred Owl occupancy increased to 0.838 (95% CI) (Higley and Mendia 2013).

For the Willow Creek Study Area (part of the NWC study area), Franklin et al. (2015) reported a mean λ of 0.975 (1985-2014; SE 0.012), indicating a decline in the Northern Spotted Owl population for this area. The mean survival rate was 0.848 (1985-2014; SE 0.009). Survival rate was thought to be negatively influenced by the presence of Barred Owl. The Willow Creek Study Area has experienced a dramatic increase in Barred Owl detections, from one barred owl site in 1991 to 22 in 2014 (Franklin et al. 2015). Spotted Owl territories having Barred Owl detections ranged between 0-37 within the same timeframe (Franklin et al. 2015).

When Barred Owls were first detected in a Northern Spotted Owl territory on Green Diamond Resource Company land, Humboldt County, Northern Spotted Owls no longer responded to taped playback calls, demonstrating they were either absent from the territory or not responsive (Diller 2012). In 2014, there were 268 Barred Owl detections on Green Diamond Resource Company land, representing an estimated 65 territories, and demonstrates a 76% increase in detections from 2011-2014 (GDRC 2015). Forty-eight of the 65 territories were within the density study area (GDRC 2015).

Barred Owl removal experiments were conducted on Green Diamond Resource Company land to assess the impacts Barred Owls were having on Northern Spotted Owl presence (Diller 2012 and GDRC 2015).

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4776 When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within
4777 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that
4778 some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to
4779 Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed
4780 (Diller 2012).

4781 During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley
4782 Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97%
4783 adults, 92.9% female, 65.3% male), with at least one Barred Owl removed from 28 historic Northern
4784 Spotted Owl territories, and >2 removed from 21 Northern Spotted Owl territories (Higley 2014).
4785 Spotted Owl occupancy since the removal has occurred has not yet been reported.

Comment [JEH20]: I am fairly certain that Hoopa has documented some positive effects of removal on spotted owls, contact Mark Higley at Hoopa.

4786 Spotted Owls will reduce their calls or not call at all if Barred Owls are in the vicinity (Cozier et al. 2006,
4787 Diller 2012, Sovern et al. 2014), making it more difficult to detect Spotted Owls if Barred Owls are
4788 present. Thus, standard surveys might result in occupancy status being misclassified (e.g., a false-
4789 negative survey -- designating sites as unoccupied by Spotted Owls when in reality Spotted Owls are
4790 present but are not vocalizing). Beyond land management implications (e.g., timber harvest or not), this
4791 behavior shift by the Spotted Owl may also have implications for reproduction because calls are used to
4792 defend a territory and locate mates, and during pair bonding and prey delivery to the nest site (USFWS
4793 2013).

4794 The ecology of Barred Owls gives them a competitive advantage over Spotted Owls regarding
4795 reproductive success and productivity (Courtney et al. 2004, USFWS 2013). Barred Owls have larger
4796 clutches (1 to 5 chicks) than Spotted Owls (1 to 3 chicks), and Barred Owls may produce up to three
4797 clutches per season, both of which may lead to higher productivity (Gutiérrez et al. 1995, Mazur et al.
4798 2000, Gutiérrez et al. 2007). Some studies have found that Spotted Owls often do not breed every year,
4799 and that productivity varies from year to year (Forsman et al. 1984, Mazur et al. 2000, Rosenberg et al.
4800 2003, Forsman et al. 2011).

4801 The literature suggests that Barred Owls are displacing Northern Spotted Owls from their territories, and
4802 Spotted Owls are forced into lower quality breeding and foraging habitat (USFWS 2013, Sovern et
4803 al. 2014). In addition, detecting Spotted Owls during surveys is likely hindered because Spotted Owls
4804 vocalize less often when Barred Owls are nearby (Crozier et al. 2006). Displacement and reduced
4805 vocalizations are thought to negatively impact Spotted Owl productivity (Forsman et al. 2011). As
4806 discussed previously, Barred Owls are prey generalists and Spotted Owls are prey specialists; a factor
4807 that may play into reproductive success (USFWS 2013).

4808 Barred Owls are aggressive toward Spotted Owls, and have attacked Spotted Owls on occasion.
4809 Courtney et al. (2004) reported several instances where Spotted Owls were attacked by Barred Owls,
4810 and where surveyors were attacked by Barred Owls while playing Spotted Owl calls. Leskiw and
4811 Gutiérrez (1998) suspected that a Barred Owl killed and partially consumed a Spotted Owl. Johnston
4812 (2002, as cited by Courtney et al. 2004) presented evidence that a Barred Owl likely killed a juvenile
4813 Spotted Owl. It is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities

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were due to territorial aggression (USFWS 2013). By comparison, instances reported of Spotted Owl aggression toward Barred Owls are few (George and Lechleitner 1999, A. Ellingson, pers. comm, P. Loschl, pers. comm as cited in Courtney et al. 2004).

At least two species of feather lice (Phthiraptera) and one Hippoboscid fly that are known Barred Owl ectoparasites also parasitize Northern Spotted Owls, suggesting that invasive Barred Owls may expose Northern Spotted Owls to novel pathogens via ectoparasites (Hunter et al. 1994). Lewicki et al. (2015) sampled blood from Northern Spotted Owls and western Barred Owls throughout Siskiyou, Trinity, Humboldt, and Mendocino counties in an attempt to evaluate parasite dynamics and the related impacts of Barred Owl range expansion on spotted owls. Specific results related to parasite prevalence are noted within the Disease section of this report below. The study suggests that parasite dynamics in Northern Spotted Owls are not solely influenced by the presence or absence of Barred Owls, but that more research is needed to assess roles of additional factors relating invasion to host/parasite dynamics (Lewicki et al. 2015).

The literature suggests that Barred Owls have impacted Northern Spotted Owls in a variety of ways, including reduced survival and occupancy, displacement, reduced detection rates, and predation. In the northern portion of the Northern Spotted Owl range, where Barred Owls have existed longer and are more densely distributed, the realized negative impacts are severe. In California, where Barred Owl occurrences are relatively recent, the negative impacts are less severe at this point. However, in portions of the northern California range where Barred Owls have become more common in recent years, impacts to Northern Spotted Owls, including displacement and declines in occupancy and survival rates, have been observed.

Disease

The 2011 Revised Recovery Plan (USFWS 2011a) states, “It is unknown whether avian diseases such as West Nile virus (WNV), avian flu, or avian malaria... will significantly affect Spotted Owls.” Likewise, disease occurrence in Spotted Owls is likely under-reported because Spotted Owls tend to inhabit remote areas and, therefore, there is a small likelihood of carcass recovery for testing (K. Rogers, personal communication, September 25, 2014).

In California, two studies have investigated the prevalence of WNV in raptor populations (Hull et al. 2006, Hull et al. 2010). In migrating and wintering hawks, Hull et al. (2006) found of the 271 red-tailed hawks, 19 red-shouldered hawks, and 30 Cooper’s hawks tested, WNV antibodies were present in 5-58 percent. However, no individuals that tested positive demonstrated any visible signs of illness. Conversely, WNV antibodies were not detected in 62 Northern goshawks, 209 Spotted Owls, and 22 great gray owls sampled in the Sierra Nevada, suggesting low prevalence or high mortality in these species (Hull et al. 2010). Only one recent case of WNV infection was reported in a dead California Spotted Owl in 2013 from the Sierra Nevada (K. Rogers, personal communication, September 25, 2014).

Research conducted elsewhere in North America, suggests WNV infection causes morbidity and mortality in several species of raptors. In Colorado, WNV infection was highest in red-tailed hawks and great-horned owls (compared to other raptor species) admitted to wildlife rehabilitation centers; clinical

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signs were variable and included emaciation, weakness, and inability to perch, fly, or stand (Saito et al. 2007). Additionally, 40 of 56 dead raptors, evaluated for WNV, were positive; histological lesions most often included encephalitis and myocarditis (Saito et al. 2007). In Georgia, 40 out of 346 raptors tested for WNV were positive, including 4 Barred Owls, one great horned owl, and four eastern screech owls (Ellis et al. 2007). All 40 cases occurred during summer and late fall (Ellis et al. 2007), when mosquito activity is most common. Gancz et al. (2004) investigated an outbreak of WNV in several species of captive owls in Ontario, Canada, including one Spotted Owl and eight Barred Owls. Owl species with more northerly breeding ranges (e.g., snowy owl, great gray owl) showed higher rates of infection than more southerly breeding species (e.g., barn owl, eastern screech owl) (Gancz et al. 2004). WNV infection in these captive birds was found to coincide with a summer louse fly (*Hippoboscidae*) infestation, suggesting bites from the louse flies aided in WNV transmission (Gancz et al. 2004). Additionally, there is evidence that raptors can become infected with WNV after feeding on infected prey (Nemeth et al 2006). WNV infection is routinely identified in squirrels (Family: *Sciuridae*) (Padgett et al. 2007), as well as jays and other songbirds (Hull et al. 2010; Wheeler et al. 2009) in California; the range of these species may overlap with that of Northern Spotted Owls, possibly posing an additional infection risk.

Other diseases that may impact Spotted Owls are largely unknown at this time. There are no known studies or cases of mortality caused by avian (flu) influenza in Spotted Owls. According to Rogers pers comm. (2014), prevalence of avian influenza in the spotted population is expected to be low since the disease is primarily carried by waterfowl and shorebirds, two groups that have low interaction with Spotted Owls. In addition, little information is available on the prevalence of avian malaria or Leucocytozoonosis (both blood parasites) in Spotted Owls. Significant mortality due to avian malaria or Leucocytozoonosis is rarely reported in avian species (K. Rogers, personal communication, September 25, 2014), with the exception of island endemics or birds in captive situations and most infected birds seem to recover or may have chronic infections. Impacts of parasitic infection to Northern Spotted Owl survival are also unknown. However, Martinez et al. (2010), documented lowered survival of wild-breeding female blue tits (*Cyanistes caeruleus*) in Spain infected with *Haemoproteus* parasites (*Haemoproteus* and *Leucocytozoon* spp.).

Thomas et al.(2002) documented a fatal infection of a *Borrelia* sp. in a Northern Spotted Owl from Washington. Borreliosis is transmitted by ticks, potentially including those ticks accidentally transferred to Spotted Owls from their rodent prey. Hunter et al. (1994) documented a tick (*Ixodidae*) and a flea (*Ceratophyllidae*) from Northern Spotted Owls, and considered them as likely accidentals from rodent prey. Northern Spotted Owls also hosted two species of feather lice (*Phthiraptera*), *Strigiphilus syrnii* and *Kurodaia magna*.

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There are a handful of studies that have documented blood and intestinal parasites in owl species. Ishak et al. (2008) tested 111 Spotted Owls, and 44 Barred Owls, and 387 owls of nine other species for Leucocytozoon, Plasmodium, and *Haemoproteus* spp. (haemosporidian blood parasites). The study found both California and Northern Spotted Owls carried the greatest number of Leucocytozoon parasite lineages, California Spotted Owls had a higher prevalence of infection with more multiple infections than Northern Spotted Owl, and Barred Owls along the coast had lower rate of infection (15%) than Northern Spotted Owls (52%) and California Spotted Owls (79%). They suggested that the

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greater infection load of Spotted Owls compared to Barred Owls may favor the later in competitive interactions. Interestingly, Ishak et al (2008) documented the first ever case of Plasmodium infection in a Northern Spotted Owl. Gutiérrez (1989) tested 105 Spotted Owls (seven populations and all subspecies) for hematozoa (a blood parasite) and found all to be infected with at least one hematozoan. This study suggested that the owls large home range, spanning various forest types, the time spent caring for and provisioning young, and their long life span make this species more susceptible to higher rate of infection compared to other bird species (Gutiérrez 1989). From 2008 to 2012 blood samples were analyzed from Northern Spotted Owls (n=98) and western Barred Owls (n=49) throughout Siskiyou, Trinity, Humboldt, and Mendocino counties and tested for blood parasite loads (Lewicki et al. 2015). For comparison, blood samples were also analyzed from eastern Barred Owls (n=135) housed in wildlife rehabilitation centers throughout their historic range. Lewicki et al. (2015) found Haemoproteus spp. infection prevalence higher in Northern Spotted Owl (76.5%) than western Barred Owl (30.6%), and highest in eastern Barred Owl (88.1%), and infection intensity was nearly 100 times greater in Northern Spotted Owl than western Barred Owl. The study did not directly evaluate the impacts of blood parasite infections on the owl species assessed (Lewicki et al. 2015).

Hoberg et al. (1989) reported that 71% of the Northern Spotted Owls from western Oregon that they tested were infected with helminth parasites including nematodes, cestodes, and acanthocephalans. Any adverse effect from these parasites was not documented.

In Oregon, Hoberg et al. (1993) reported enteric coccidia (intestinal parasite) in a juvenile female Northern Spotted Owl. The presence of the parasite did not appear to contribute to the juvenile Spotted Owl's death; however, death has been attributed to this type of parasite in other raptor species (Hoberg et al. 1993). In this case study, transmission was thought to be through consumption of infected small mammal prey (e.g., mice, squirrels, woodrats). Trichomonosis is a concern for Spotted Owls if they consume Columbids infected with the protozoan parasite, *Trichomonas gallinae*, where species ranges overlap. The Department's Wildlife Investigation Lab documented two cases of Trichomonosis in California Spotted Owl in 2012, two cases in Northern Spotted Owl in 2014 from the Coastal Mountain Range, north of San Francisco Bay, and one in a great gray owl in 2006 and in 2007 (K. Rogers, personal communication, September 25, 2014).

In northwestern California, Young et al. (1993) found Hippoboscids flies on 62 of the 382 Northern Spotted Owls captured over five years between April and September, with higher prevalence in adults than juveniles. The flies were more abundant in years when fall temperatures were high, winter precipitation were low, and summer temperatures were low, suggesting fly abundance is climate dependent. Consequently, the frequency of Hippoboscids flies in the Northern Spotted Owls population may vary in intensity as climate changes (Young et al. 1993). Hippoboscids may reduce the fitness of heavily infected individual Spotted Owls, and may act as vectors for other pathogens.

To address the shortfall of information on disease impacts to Spotted Owls, Recovery Action 17 of the 2011 Recovery Plan is, "Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, Plasmodium spp.) and address as necessary" (USFWS 2011a). In addition, the Department's Wildlife Investigation Lab is currently conducting a raptor disease and contaminant surveillance study that will

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help determine disease occurrence and contaminant exposure in raptor populations statewide, including both Northern and California Spotted Owls. This study will include targeted surveillance for a wide array of diseases and contaminants such as, WNV, mange, Avian Trichomonosis, Avian Chlamydiosis, and Avian Herpesvirus, AR and lead poisoning.

Contaminants

Northern Spotted Owls feed on a variety of prey species, but mainly small mammals make up a bulk of their diet. Consequently, the main contaminant threat to the owls is anticoagulant rodenticide poisoning. The anticoagulant rodenticides (ARs) are grouped into first-generation compounds (diphacinone, chlorophacinone and warfarin), requiring several doses to target species before death occurs, and second-generation ARs (SGARs; e.g., brodifacoum, brodifacoum, difenacoum and difethalone), requiring only a single dose. Second generation ARs are more acutely toxic and persist in tissues and in the environment (Gabriel et al. 2013).

Numerous field monitoring studies on other raptor and owl species indicate lethal and sublethal impacts of AR exposure (Mendenhall and Pank 1980, Stone et al. 2003, Walker et al. 2008, Albert et al. 2009, Murray 2011, Thomas et al. 2011, Christensen et al. 2012, Sánchez-Barbudo et al. 2012). In California, Lima and Salmon (2010) analyzed tissues from 96 raptors of 10 species brought to wildlife rehabilitation centers in San Diego and the Central Valley, and found that 69% (Central Valley) to 92% (San Diego) had been exposed to anticoagulant rodenticides. In Massachusetts, Murray (2011) tested 161 wild Red-tailed Hawks, Barred Owls, Eastern Screech Owls (*Megascops asio*), and Great Horned Owls and found 86 percent with ARs in liver tissue, of which 99 percent was brodifacoum, a SGAR. Another study in New York found ARs present in 49 percent of wild raptors tested (n=265; 12 species), most prevalent in Great Horned Owls (43/53; 81%) and less prevalent in Barred Owls (3/13; 23%), with SGARs (brodifacoum and brodifacoum) being the most frequently detected (Stone et al. 2003). Nine of the 53 Great Horned Owls and one of the 13 Barred Owls died in this study, revealing a mortality rate of 17 percent and 8 percent, respectively (Stone et al. 2003).

In addition to the field monitoring that demonstrates widespread exposure of raptor/owl species to ARs, investigations of wildlife mortality incidents show that raptors comprise two-thirds of the anticoagulant-related wildlife mortalities (Department's Wildlife Investigation Lab files). These incidents are most likely to be reported in more populated areas, but it is reasonable to assume that any area where ARs are used for outdoor rodent control would share a similar pattern. The Department's Wildlife Investigation Lab documented several recent cases of AR poisoning for the California Spotted Owl (K. Rogers, personal communication, September 25, 2014); two cases in 2013, and two in 2014. However, at this time it is unknown how widespread morbidity and mortality is for the spotted owl population in California. As mentioned above, the Wildlife Investigation Lab is currently conducting a statewide raptor disease and contaminant surveillance study that will target AR occurrence in raptor populations to help shed light on the extent of this threat.

Few laboratory studies have been conducted that test impacts of ARs on raptors, and no known studies have evaluated impacts on spotted owls. In a laboratory study by Mendenhall and Pank (1980), three

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species of captive owls fed mice or rats killed with the ARs bromadiolone, brodifacoum, or diphacinone (SGARs) died of hemorrhaging, those fed mice or rats killed with difenacoum (SGAR) displayed sublethal hemorrhaging, and those fed mice or rats killed with fumarin or chlorophacinone (1st generation ARs) displayed no signs of illness. Eastern Screech Owls were fed diphacinone for 7 days in a laboratory setting and monitored for 21-days post exposure (Rattner et al. 2013). This study found that toxicity appeared quickly upon exposure to lethal levels, but returned rapidly to normal in most owls after exposure was terminated (Rattner et al. 2013).

Bond et al. (2013), notes the use of rodenticides (prevents damage to young trees from rodents browsing) or herbicides (suppresses shrubs to allow growth of trees) in burned forests and the potential threat of these substances to Spotted Owls. The use of herbicides and rodenticides may reduce the prey habitat and abundance for Spotted Owls, however it is unlikely the activity would be a major source of rodenticide exposure for owls because the type of poison used are generally 1st generation anticoagulant rodenticides, which are not as persistent or toxic in their target species (S. McMillin, personal communication, September 25, 2014).

In illegal marijuana grows, widespread in the Northern Spotted Owl range, growers typically apply second generation AR at the base of plants to prevent small mammals from damaging the crop (Thompson et al. 2013, Gabriel et al 2013). These 2nd generation rodenticides present a risk to predators of small mammals, such as the Northern Spotted Owl, because this type of rodenticide is more acutely toxic, and persists in tissues and in the environment (Gabriel et al. 2013).

The fisher is a species whose range and prey base overlaps with the Northern Spotted Owl (Zielinski et al. 1999, Zielinski et al. 2004), thus, the impacts of rodenticides in fisher may also be an impact to Northern Spotted Owl. Thompson et al. (2013) studied impacts of ARs to fishers in the southern Sierra Nevada and found impacts of ARs in association with illegal marijuana grows significant. Toxicants found at grow sites within the study area included brodifacoum and bromadiolone (SGARs), carbofuran (a pesticide currently banned in the United States), and malathion (an insecticide). Thirty-nine out of 46 fisher carcasses recovered (88%) tested positive for one of more AR compound with brodifacoum being the most common (Thompson et al. 2013). Another fisher study in California's Sierra Nevada found 79 percent of fisher carcasses (n=58) tested were exposed to ARs, and of that, 96 percent were exposed to SGAR compounds (Gabriel et al. 2013). Given these results, and the presumed extent of illegal marijuana grows in California (Gabriel et al. 2013, Thompson et al. 2013), it is likely that exposure to AR prevalence is widespread and is impacting Northern Spotted Owls in California to some extent. However, the effects and prevalence of poisoning events on overall fitness (e.g., survival and fecundity) remains unknown.

5001 Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytophthora ramorum*) which infects a variety of species. It is particularly lethal to tanoaks (*Lithocarpus densiflorus*) and several species of true oaks (*Quercus* spp.). In other species it may cause dead bark, leaf blight, and twig dieback (Shaw 2007, USFWS 2011a), and some hosts may be asymptomatic. Nearly all tree species in mixed evergreen

Comment [A21]: Note to external reviewers: A publication is in the works to assess the potential impacts of ARs associated with marijuana plants to spotted owls, using barred owls as a surrogate. An abstract regarding this work, noted that the study found 40% of all Barred Owls tested were exposed to ARs in suitable NSO habitat within managed timberland in NW CA. The full analysis and result write-up are underway. Information from this effort will likely inform us on exposure to and impacts of ARs to owl fitness. This information will have to be added after external review, assuming it is ready prior to submission of this report to the Fish and Game Commission.

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5006 and redwood-tanoak forest types may be hosts (Davidson et al. 2003, Garbelotto et al. 2003). According
5007 to Goheen et al. (2006),

5008 “The pathogen has a wide host range including Douglas-fir, grand fir, coast redwood, and many
5009 other tree and shrub species common in Oregon and Washington forests. Tree mortality, branch
5010 and shoot dieback, and leaf spots result from infection depending on host species and location.
5011 *Phytophthora ramorum* spreads aerially by wind and wind-driven rain and moves within forest
5012 canopies and tree tops to stems and shrubs and from understory shrubs to overstory trees. The
5013 pathogen survives in infected plant material, litter, soil, and water. It is moved long distances in
5014 nursery stock... State and Federal personnel regularly survey forests and nurseries in the Pacific
5015 Northwest to detect the disease.”

5016 In 1995, sudden oak death was discovered in California within Mill Valley (Marin County), and has since
5017 spread across multiple coastal counties impacting coastal live oaks and tanoak forests within (Tietje et
5018 al. 2005). According to recent submission to the GIS tool “OakMapper”, confirmed locations of *P.*
5019 *ramorum* in California range from the coastal ranges in Monterey County and north up through portions
5020 of Humboldt County (California Oak Mortality Task Force 2015). Many studies have documented the
5021 widespread damage and mortality of oak-tanoaks coastal woodlands from Humboldt to Monterey
5022 counties (Rizzo and Garbelotto 2003, McPherson et al. 2005, Goheen et al. 2006, Cobb et al. 2009, Cobb
5023 et al. 2012). Shaw (2007) indicated that the disease in California is likely linked to coastal climates that
5024 are typically warmer and wetter than more inland forest types. There is large-scale concern regarding
5025 the impacts of this disease on forest structure and composition in California, and the associated impacts
5026 to wildlife species that inhabit these forests.

5027 Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases
5028 quickly. Cobb et al. (2009) examined mortality caused by sudden oak death within coastal redwood
5029 forests from Sonoma to Monterey counties. Tanoaks confirmed to be infected died on average within 1-
5030 6 years, and larger trees that were close to other infected species, such as the California bay laurel
5031 (*Umbellularia californica*), were infected to a greater extent than smaller, more remote trees. Tanoaks
5032 survived longer within redwood and Douglas-fir dominated forests than in hardwood dominated stands
5033 (Cobb et al. 2009). In Marin County, McPherson et al. (2010) examined the survival of coast live oaks,
5034 black oaks (*Q. kelloggii*) and tanoaks once infected by sudden oak death. The study found that live oak
5035 and tanoak survival declined as a function of disease state. Coast live oak survival was 11.7 to 15.8 years
5036 for asymptomatic trees; 7.5 to 11.7 years for trees bleeding only; and 2.6 to 3.4 years for trees bleeding
5037 with ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010). Tanoak survival was 8.8
5038 years for asymptomatic trees; 5.9 years for trees bleeding only; and 1.7 years for trees bleeding with
5039 ambrosia beetles and/or bark beetle infestations (McPherson et al. 2010).

5040 After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi
5041 and insects is common and impacts survival times. For example, McPherson et al. (2005) found
5042 symptomatic progression and eventual mortality of coast live oaks and black oaks due to sudden oak
5043 death followed a similar sequence: bleeding, beetle colonization, emergence of *Hyposylon thouarsianum*
5044 (another fungal infection), and then death. Here, approximately 50% of bleeding live oaks were infected

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5045 by ambrosia beetles and bark beetles, or showed evidence of past beetle infestation, whereas beetles
5046 infested tanoaks with less frequency (McPherson et al. 2005).

5047 It is unlikely that the impact of sudden oak death on oak-tanoak forests will subside in the future. Brown
5048 and Allen-Diaz (2005) examined past, current and future changes of coast live oaks-bay laurel woodland
5049 structure and composition within the San Francisco Bay Area due to sudden oak death infections. There
5050 was a 2-27% loss of coast live oak basal area (m²/ha) during the study period (2002-2004), a 4-55% loss
5051 in the recent past (5-10 years prior to 2002) through 2004, and a projected 15-69% coast live oak basal
5052 area loss in the future, with a total stand basal area was predicted to decrease up to 42% within the next
5053 5 years (Brown and Allen-Diaz 2005). Meentemeyer et al. (2009) predicted that with no control
5054 measures, sudden oak death will increase by 10-fold by 2030, particularly along the coast north of San
5055 Francisco. The model suggests that wet weather conditions exacerbated by predicted change climate
5056 regimes serve to double the rate of spread in California (Meentemeyer et al. 2009). Predictive models
5057 note forests at high risk to sudden oak death in California occur in coastal forests of Santa Barbara
5058 County north through Humboldt County (Koch and Smith 2012).

5059 Oak-tanoak forests are present within the Northern Spotted Owl range in California and are an
5060 important component to owl habitat (see Habitat Section of this report). Hardwood trees within conifer
5061 stands are not only important structural components within stands of suitable spotted owl habitat, but
5062 they also provide cover and food resources for ~~Oak and tanoak forest types and as elements within~~
5063 ~~conifer forest provide habitat for the owl's main prey base, the dusky-footed woodrat, as well as other~~
5064 small mammals that comprise a smaller component of the owl's diet. There are no known published
5065 work evaluating the wildlife consequences of sudden oak death focus on impacts to Northern Spotted
5066 Owl habitat; however, results from these studies may inform potential or likely impacts of sudden oak
5067 death the species given what we know about owl habitat and prey needs.

5068 Within an infected study site in on Marin County, Temple and Tietje (2005) found coarse woody debris,
5069 a habitat component important for many small mammals, was 70 times higher than on an uninfected
5070 plot in Sonoma County, a difference supposedly due to sudden oak death-induced coarse woody debris
5071 generation. Within San Luis Obispo County, an area where sudden oak death has a low prevalence,
5072 areas in "high-risk" woodlands (i.e., those with species composition thought to be most impacted by
5073 sudden oak death) small mammals, including the dusky-footed woodrat, were more abundant (Tempe
5074 et al. 2005, Temple and Tietje 2005). The difference in species abundance between the sites is likely
5075 inherent, the authors' link to sudden oak death impacts of the comparison is unclear. However, these
5076 studies speculate that California bay laurel may replace coast live oak trees in the forest canopy. While
5077 having ecological importance, California bay laurel is relatively less productive than oaks as a wildlife
5078 habitat component.

5079 Only one study has provided any direct link to Spotted Owl occupancy and habitat impacts due to
5080 sudden oak death. Within Big Sur forests of California, Holland et al. (2009) indicated that California
5081 Spotted Owl were more likely to occur in forests with greater amount of tree mortality, suggesting
5082 sudden oak death could benefit owls in the short-term by generating coarse woody debris (e.g., downed
5083 logs and branches), key habitat features for the owl's prey resources. However, over the long-term,

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5084 coarse woody debris and snags will decay and the supply will diminish thus prey resources may decrease
5085 and thereby impacting habitat suitability for the owls.

5086 More generally, several studies indicate an impact on small mammal populations associated with
5087 sudden oak death infestations within coastal forests, but do not provide a link between Spotted Owl
5088 occupancy. Several studies suggested that that woodrats and mice (*Peromyscus* spp.) may benefit from
5089 immediate changes in habitat features (e.g., increase in coarse woody debris, increased shrub cover)
5090 within infected areas; however long-term abundance is less certain in the face of continued sudden oak
5091 death infection (Apigian et al. 2005, Temple and Tietje 2005). In addition, mortality from sudden oak
5092 death, or the treatment of sudden oak death outbreaks, may exacerbate problems associated with fuel
5093 accumulation and wildfire suppression (Valachovic et al. 2011).

5094 The 2011 Northern Spotted Owl Recovery Plan (USFWS 2011a) notes this disease as a potential threat
5095 “due to its potential impact on forest dynamics and alteration of key prey and Spotted Owl habitat
5096 components (e.g., hardwood trees, canopy closure, and nest tree mortality)... especially in the southern
5097 portion of the Spotted Owl’s range (Courtney et al. 2004).” However, the USFWS (2011a) asserted that
5098 the extent of the impact of sudden oak death to owl habitat, prey species, and occupancy has not been
5099 thoroughly assessed. To address the shortfall of information, Recovery Action 17 of the 2011 Recovery
5100 Plan is to “Monitor for sudden oak death and avian diseases (e.g., WNV, avian flu, Plasmodium spp.) and
5101 address as necessary” (USFWS 2011a). Monitoring techniques have been developed and may consist of
5102 regular aerial and ground surveys to assess rate of sudden oak death infection within oak-tanoak forest
5103 communities (Mai et al. 2005). However, such monitoring will detect spread well after a local invasion is
5104 established. Early detection techniques, such as eDNA sampling, may allow quicker intervention, but the
5105 efficacy of the various methods (Cobb et al 2013) still needs thorough evaluation.

5106 **Predation**

5107 The 2011 Revised Recovery Plan (USFWS 2011a) states,

5108 “Known predators of Spotted Owls are limited to great horned owls (Forsman et al. 1984), and,
5109 possibly, barred owls (Leskiw and Gutiérrez 1998). Other suspected predators include northern
5110 goshawks, red-tailed hawks, and other raptors (Courtney et al. 2004). Occasional predation of
5111 Spotted Owls by these raptors is not considered to be a threat to Spotted Owl populations, so
5112 no criteria or actions are identified.”

5113 No new information has been generated since this statement was made, and therefore, the threat of
5114 predation to Northern Spotted Owls remains negligible.

5115 **Recreational Activities**

5116 Natural stress events (predator interactions, precipitous weather, disease, care of young), or
5117 anthropogenic stress events (vehicle traffic and noise, hikers) can impact species on multiple levels. This
5118 may include physiological impacts such as suppressed reproduction and growth (REFS), or behavioral
5119 responses such as avoidance (e.g., vocalizations and flushing).

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5120 Collecting and analyzing fecal samples has been shown to be effective at detecting stress hormone
5121 production (e.g., glucocorticoids) in owls (Wasser and Hunt 2005). By employing this methodology, a
5122 study conducted in the Shasta Trinity and Mendocino National Forests, California, found Northern
5123 Spotted Owls exhibit more stress when exposed to motorcycle activities, and exhibit lower reproductive
5124 success when exposed to busy roads (Hayward et al. 2014). Wasser et al. (1997) collected fecal samples
5125 from wild Northern Spotted Owl in Washington to measures stress hormone production in relation to
5126 timber activities (e.g., logging roads timber management). Males showed a more prominent increase in
5127 corticosterone production when the disturbance occurred with 0.41 km (0.25 miles) of the home range
5128 center, and in males whose home ranges were close to clear-cut (vs. selective logging).

5129 Presence of hikers has been shown to alter owl behavior at roosting and nesting sites. Swarthout and
5130 Steidl (2001) found that juvenile and adult Mexican Spotted Owls were less likely to flush from the
5131 presence of a hiker at 212 and 224 meters, respectively, and neither juveniles nor adults were likely to
5132 alter behavior at distances 255 meter or more. At nesting territories, Mexican Spotted Owls in Utah
5133 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance
5134 with the presence of hikers (Swarthout and Steidl 2003).

5135 It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the
5136 level to which these activities may impact owl behavior, reproduction and overall survival has yet to be
5137 determined. It is unlikely anthropogenic stress events associated with recreation will impact Northern
5138 Spotted Owl reproduction and survival to any great extent, though further research is warranted.

5139 **Loss of Genetic Variation**

5140 There had previously been little evidence in the literature of loss of genetic variation and population
5141 bottlenecks for the Northern Spotted Owl (Courtney et al. 2004). However, a recent genetic study across
5142 the range of the Northern Spotted Owl provides compelling evidence that a population bottleneck may
5143 have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from
5144 352 Northern Spotted Owls from six regions across the range which included limited samples from the
5145 northern portion of the California Klamath Province.

5146 Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades)
5147 bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant
5148 evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest
5149 California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic
5150 variation and hence effective population size, do not necessarily indicate a decline in actual
5151 (demographic) population size (Funk et al. 2010) "... it is important to keep in mind that
5152 reductions in [effective population size] (detected with bottleneck tests) are different than
5153 reductions in demographic population size (detected with demographic field studies) and
5154 reductions in one of these parameters does not necessarily result in a change in the other."
5155 (Funk et al. 2010)

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The scientific review of the Draft Recovery Plan Recovery was able to review unpublished genetic studies from Dr. Susan Haig (Courtney et al. 2008). Using samples collected from 352 owls, the results provided some evidence that recent bottlenecks have occurred at various spatial scales within the Northern Spotted Owl range, but could not definitively link the genetic declines to recent population declines (USFWS 2011a, Courtney et al. 2008). Genetic scientists reviewing Haig’s work concluded that the bottlenecks observed by Haig were likely the result of recent population declines rather than the cause of decline (Courtney et al. 2008). Specifically, Courtney et al. (2008) states,

“The conclusion by Barrowclough and Coats (1985) is still appropriate here, which is that the population dynamics of the Spotted Owl likely will be more important to its short-term survival than will be its genetic makeup, regardless of the evidence for bottlenecks having occurred in the past. Our conclusions might warrant re-consideration at some future point, in the context of explicit evidence linking reductions in genetic diversity to current conditions, and current or future population performance.”

Summary of Listing Factors

The California Endangered Species Act directs the Department to prepare this report regarding the status of the Northern Spotted Owl in California based upon the best scientific and other information available to the Department (Fish & G. Code, § 2074.6, subd. (a); Cal. Code Regs., tit. 14, § 670.1, subd. (f)). CESA’s implementing regulations identify key factors that are relevant to the Department’s analyses. Specifically, a “species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities.” (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

The definitions of endangered and threatened species in the Fish and Game Code guide the Department’s scientific determination. An endangered species under CESA is one “which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease.” (Fish & G. Code, § 2062). A threatened species under CESA is one “that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA].” (*Id.*, § 2067).

The Department’s summary of listing factors are summarized below:

Present or threatened modification or destruction of habitat

Timber Harvest and Regulatory Considerations

Although the rate of nesting and roosting habitat loss has declined since the Northern Spotted Owl was listed under the federal endangered species act in 1990, assessments performed on rangewide since the

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5192 implementation of the NWFP show that habitat loss is ongoing. Wildfire and other natural disturbance
5193 has been the leading cause of habitat loss on federal land and timber harvest has been the leading cause
5194 of habitat loss on nonfederal lands since 1994. Although state regulations governing timber harvest on
5195 nonfederal lands in California (i.e., California Forest Practice Rules) are the most protective state
5196 regulations in the range of the Northern Spotted Owl, losses of nesting and roosting habitat due to
5197 timber harvest in California have continued. Since 1994, 5.8% of nesting and roosting habitat on
5198 nonfederal lands in California has been removed by timber harvest.

5199 California Forest Practice Rules

5200 Minimum habitat retention requirements are identified in the Forest Practice Rules for timber harvest
5201 occurring on privately owned land in California. Definitions for the different habitat types to be retained
5202 are also included in Forest Practice Rules. Habitat Retention requirements and definitions were
5203 developed in the early 1990s and can be found in Table 20 and Appendix 2. Retention requirements
5204 were established for a combination of nesting, roosting, and foraging habitat in the area immediately
5205 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the
5206 broader home range (1.3 mile radius).

5207 The most recent research on Northern Spotted Owl habitat requirements in California and southern
5208 Oregon have demonstrated a link between owl fitness and the amount of types of habitat, structural
5209 characteristics, and spatial configuration in a home range. This requirement for habitat heterogeneity is
5210 consistent with the general approach incorporated in the Forest Practice Rules. Although study design
5211 has varied across the major research studies, some consistent patterns have arisen. In order to support
5212 productive Spotted Owl territories, a minimum amount of older forest must be retained in the core
5213 area. The definition of 'older forest' evaluated in studies has varied, but consistently includes late-seral
5214 forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older
5215 forest in an approximately 400 acre core area.

5216 Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling
5217 cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness.
5218 Results indicate that in order to support a productive Northern Spotted Owl territory, no more than
5219 about 50% of a home range should consist of nonhabitat.

5220 The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations
5221 for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest
5222 Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls. The total acreage of
5223 recommended retention in the USFWS guidance does not differ from that found in the Forest Practice
5224 Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range
5225 must be retained in habitat. However, based on assessment of core use areas in the interior portion of
5226 the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an
5227 activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations
5228 in line with core use areas evaluated in recent work. The most significant change in the revised USFWS
5229 recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific

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5230 amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for
5231 nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained
5232 near the core is consistent with the literature.

5233 A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised
5234 USFWS recommendations (see Table 22 for the interior portion of range in California) shows large
5235 discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under
5236 the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the
5237 USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres).
5238 This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500
5239 acres spotted owl habitat to be retained within 0.7 miles and the total of 1,336 acres to be retained
5240 within 1.3 miles of an activity center can be composed of functional foraging habitat under Forest
5241 Practice Rules, a definition that is considered low quality foraging habitat by the USFWS; therefore there
5242 is no requirement in the Forest Practice Rules for this habitat include nesting or roosting habitat under
5243 the Forest Practice Rules.

5244 Our assessment of selected activity centers shows that the habitat retention guidance in the Forest
5245 Practice Rules are not always met, indicating that harvest is impacting Northern Spotted Owl at some
5246 locations. Of the activity centers evaluated, several experienced very high acreages of harvest at both
5247 the broad home range and in the core area, which would have resulted in territories that do not meet
5248 the USFWS recommendation for take avoidance, and would have resulted in declines in survival and
5249 fitness of the local owls.

5250 Documentation of habitat type, amount, and distribution present around activity centers after THPs are
5251 implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the
5252 Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if
5253 minimum retention requirements in the Forest Practice Rules are implemented as written, there is still
5254 the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated
5255 failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts
5256 that have occurred in recent years.

5257 The THP review and post-harvest follow-up process should ensure that the best scientific information is
5258 being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to
5259 which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a
5260 sample of activity centers indicates that it is not universally applied and that insufficient habitat has
5261 been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern
5262 Spotted Owl is likely to continue experiencing loss of habitat in California.

5263 Salvage Logging

5264 Several variables complicate the interpretation of owl response to fire, including variation in fire
5265 severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing
5266 and duration of research post-fire. Regardless, several studies have suggested that salvage logging after
5267 a fire or occurrence of extensive high severity burns likely have contributed to a decline in habitat use,

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5268 occupancy, or survival of Northern Spotted Owls. Although hampered by small sample size, incidental
5269 observations have documented declines in occupancy of burned areas following salvage logging.
5270 Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction
5271 probabilities, although the impacts of salvage logging were observed only in combination with other
5272 factors.

5273 The presence of snags has been suggested as an important component of prey habitat and as perch sites
5274 for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub
5275 and herbaceous cover and number of snags, may be impacted by salvage logging.

5276 Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the
5277 fire itself, by removing important structural elements and removing important prey habitat. The
5278 available information suggests that salvage logging reduces the probability that spotted owls will use
5279 burned areas and has resulted in declines in occupancy, either through abandonment or declines in
5280 survival.

5281 *Wildfire*

5282 Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and
5283 wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994,
5284 after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to
5285 wildfire, and most of this loss has occurred in the Klamath Province.

5286 The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to
5287 use burned areas extensively, although nesting and roosting general occurred only in unburned or low-
5288 severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by
5289 California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in
5290 burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some
5291 evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

5292 Conversely, Northern Spotted Owls in southern Oregon were shown to have declines in occupancy
5293 following fire. These declines resulted from both high extinction rates in burned areas and low
5294 colonization rates.

5295 Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to
5296 experience declines in survival. Food limitation in burned areas may have been a factor in declining
5297 survival rates. These observed declines in southern Oregon may be confounded by the occurrence of
5298 post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl
5299 subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in
5300 the year following fire; these owls were not tracked to investigate potential longer-term effects.

5301 Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or
5302 areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance
5303 for foraging.

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5304 The available information suggests that wildfires can have positive effects on Northern Spotted Owls
5305 when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without
5306 removing important nesting and roosting habitat components at the territory scale. However,
5307 uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating
5308 required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed
5309 in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be
5310 used as a management tool.

5311 Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California
5312 included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades,
5313 fires have become more frequent and average fire size has increased. In some cases fires have also
5314 burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry
5315 and hot conditions). Because climate change will likely increase the likelihood of conditions that support
5316 fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

5317 Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue
5318 experiencing loss of habitat in California.

5319 *Climate Change Impacts to Forest Composition and Structure*

5320 Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate
5321 projection scenarios specific to California, the most notable response to increase temperature was a
5322 shift from conifer-dominated forests (e.g., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g.,
5323 Douglas fir-tan oak) in the northern half of the state), expansion of conifer forests into the northeast
5324 portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine
5325 forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-
5326 tan oak forests, and advancement of conifer-dominated forests (e.g., redwood and closed-cone pine
5327 forests) along the north-central coast. Tree productivity along California's north-central coastal and at
5328 high elevation forests may increase in response to increased growing season temperatures; however,
5329 reductions in summer fog in concert with increased temperatures may reduce productivity of redwood
5330 forests along the coast. In addition, the literature suggests that climate change variables will increase
5331 the severity and frequency of wildfires within the Northern Spotted Owl range.

5332 Although climate projection models have uncertainties built-in, it is apparent from the literature that
5333 forests within California will likely experience some level of elevational and latitudinal shifts, changes in
5334 species composition, and alterations in fire regimes. For the Northern Spotted Owl, who has a heavy
5335 reliance on specific forest structure components and tree species composition, and associated prey
5336 habitat and abundance, implications of such forest shifts and fire regime changes may prove
5337 unfavorable to the species over time. During long-term landscape planning related to Northern Spotted
5338 Owls and their habitat, potential climate change impacts should be analyzed and incorporated.

5339 *Other Mechanisms of Habitat Loss*

5340 Sudden Oak Death

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5341 Sudden oak death syndrome is recognized as a potential threat to Northern Spotted Owls due to
5342 impacts on forest structure and composition, and consequently alteration of prey habitat and
5343 abundance. The disease is particularly lethal to tanoaks and several species of true oaks. Confirmed
5344 locations of sudden oak death in California range from the coastal ranges in Monterey County and north
5345 up through portions of Humboldt County. Portions of California coastal forests at a high risk of infection
5346 have been identified in Santa Barbara County north through Humboldt County.

5347 Predictive modeling studies indicate that the disease is projected to increase 10-fold by 2030 in
5348 California, which could be exacerbated by wetter weather conditions on the coast predicted by climate
5349 change models. Given this, there is concern over the potential impact of sudden oak death in California
5350 to Northern Spotted Owls in the future. For instance, oak-tanoak forests support the dusky-footed
5351 woodrat, one of the owl's main prey species, as well as other small mammals that comprise a smaller
5352 component of the diet. If abundance of prey is altered within the range of the Northern Spotted Owl
5353 due to decreases in oak-tanoak forests, negative impacts to owls will likely ensue.

5354 Though no studies have yet evaluated the consequences of sudden oak death specific to Northern
5355 Spotted Owl habitat and fitness in California, there is evidence that habitat and prey abundance will be
5356 impacted in the face of this disease, and impacts will vary spatially and temporally. The literature
5357 suggests that short-term impacts may initially provide an increase in prey habitat and abundance, and
5358 thus may lead to an increased owl occupancy rate. However, this phenomenon will likely subside when
5359 habitat conditions deteriorate over time or tree species composition changes to a point the area can no
5360 longer support key owl prey species.

5361 | The extent of sudden oak death impacts, as well as impacts resulting from control measures, to
5362 Northern Spotted Owl habitat, prey species, and occupancy needs to be thoroughly assessed. Early
5363 detection techniques should be explored and implemented within coastal California forests so that
5364 negative impacts can be realized and remediated, if possible.

5365 Marijuana Cultivation

5366 Illegal and legal marijuana cultivation in remote forests on public and private land throughout California
5367 has been on a steady increase. Within the range of the Northern Spotted Owl, Shasta, Tehama,
5368 Humboldt, Mendocino, and Trinity counties comprise the areas known for the most marijuana
5369 cultivation in California due to the remote and rugged nature of the land, making cultivation difficult to
5370 detect, and habitat conditions favorable for growing marijuana (e.g., wetter climate, rich soils). Given
5371 the difficulties in detecting both legal marijuana cultivation sites and the lack of reporting legal
5372 cultivation sites, actual distribution and density of marijuana cultivation is likely larger and higher than
5373 represented in datasets collected to date.

5374 Activities associated with cultivation (e.g., removal of large trees, degradation of riparian habitat) may
5375 negatively impact Northern Spotted Owl habitat, though data on the extent of this impact is not well
5376 known. Areas with higher prevalence of marijuana cultivation may also contain high numbers of
5377 Northern Spotted Owl activity centers. The level of impact likely depends on several factors, including
5378 the density of cultivation sites in proximity to owl activity centers and how much owl habitat is affected

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5379 and to what extent. Given that marijuana cultivation is on the rise in California, a thorough assessment
5380 of potential habitat impacts to Northern Spotted Owls should be implemented.

Comment [JEH22]: Discuss rodenticides in this section or provide summary contaminants somewhere under Summary of Listing Factors.

5381 **Abundance and Demographic Rates**

5382 Few studies have attempted to examine range-wide Northern Spotted Owl population estimates. Survey
5383 methodology and effort does not allow for reliable estimates across the range or within California, and
5384 does not effectively sample nonterritorial floater individuals. Northern Spotted Owl densities vary
5385 across the range and forest types; therefore, extrapolating the few local estimates across the range of
5386 the subspecies would result in biased estimates of abundance. The Department's Spotted Owl Database
5387 houses a cumulative tally of all historic owl observations and activity centers, and for this reason it is
5388 inappropriate to use the Dataset as a surrogate for abundance and density estimates. The increase in
5389 number of activity centers over time is more likely the result of expanded survey effort than
5390 establishment of new activity centers. In addition, across most of the Northern Spotted Owl range
5391 establishment of new nesting and roosting habitat that is suitable for supporting an activity center is a
5392 slow process given tree species growth rate (with a possible exception on the coastal redwood forests),
5393 and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

5394 One recent study made use of the immense amount of data available on Northern Spotted Owl habitat
5395 requirements and availability, home range sizes, age-specific survival rates, age-specific fecundity,
5396 dispersal behavior, and impacts of Barred Owl on survival, to model source-sink dynamics across the
5397 range of the owl. In addition to an evaluation of source-sink dynamics, outcomes of the model included
5398 a range-wide population size estimate, and the proportion of the population in each modeling region
5399 and physiographic province noted in the 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The
5400 study estimated 3,400 female Northern Spotted Owls range-wide, with over 750 females in the Inner
5401 California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling
5402 regions. Three provinces located in California were estimated to contain over 50 percent of the range-
5403 wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a
5404 stronghold for the population. Even though the complexity of the model may limit its ability to
5405 accurately model population estimates, the results suggest that California's population of Northern
5406 Spotted Owls is an important component of the range-wide population.

5407 Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource
5408 Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for
5409 more than two decades to assess demographic parameters such as population growth, survival,
5410 fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study
5411 areas range-wide. In California, the most recent meta-analysis covering years 1985-2008 reported a
5412 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline
5413 per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the
5414 Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation
5415 study area reported a 2.3% population decline per year through 2012. When converting estimates for
5416 population change to estimates of realized population change (i.e., the proportional change in estimated

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5417 population size relative to population size in the initial year of analysis) two study areas in California
5418 (Green Diamond Resource Company and Northwest California) showed estimated population declines of
5419 about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight
5420 decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary
5421 meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across
5422 the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The
5423 ongoing analysis has revealed declines in California between 32 and 55% over the study period.

5424 In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young
5425 produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged
5426 from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green
5427 Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian
5428 Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in
5429 Washington and Oregon. Although less severe than in Washington and much of Oregon, all three
5430 California study areas show declines in survival.

5431 Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in
5432 California give us information on current estimates for reproductive success (number of young fledged
5433 per monitored site) and survival, and are consistent with a continued decline within all demographic
5434 study areas in California. In the coastal portion of the Northern Spotted Owl range in California, many
5435 areas reported consistently low reproductive success from 2011-2013, including some of the lowest
5436 reproductive success rates on record in 2013 despite weather conditions that would typically support
5437 good reproductive success. This was observed on many timber company lands, tribal lands, and National
5438 Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In
5439 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive
5440 rate since 2009.

5441 The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study
5442 areas in California reflected trends on non-federal lands because two study areas are on non-federal
5443 lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl
5444 habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal
5445 land. However, the authors also suggest that results depict an optimistic view of the overall population
5446 status of the Northern Spotted Owl on private lands because the non-federal lands included in the
5447 demographic study areas are managed for owls. Results from the demographic study areas are thought
5448 to be representative of federal lands and areas of mixed federal and private lands throughout the range
5449 of the Northern Spotted Owl because the study areas were large, distributed across a broad geographic
5450 region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

5451 Occupancy data is based on the presence or absence of owls from known sites. In order for estimates of
5452 occupancy to be valid, survey efforts must be consistent over time and the detection probability (the
5453 probability of detecting an owl if one is present) must be estimated; inconsistent survey effort can lead
5454 to high variation in detection probability which can skew estimates of occupancy if not accounted for.

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5455 Although an evaluation of occupancy rates has not been included in previous demographic meta-
5456 analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the
5457 number of territorial owls detected on all 11 areas was lower at the end of the study period than at the
5458 beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling
5459 for the first time. Preliminary results show that occupancy rates have declined at all three California
5460 study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on
5461 occupancy by increasing the local territory extinction rate.

5462 Occupancy has been shown to be in decline for areas outside the California demographic study areas as
5463 well. For example, the southern Cascades and interior Klamath provinces of California determined
5464 occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl
5465 declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

5466 It is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of
5467 demographic rates across the range indicate the declines in demographic parameters, including
5468 population size, have accelerated. The level of decline does not seem to be slowing even with the
5469 implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at
5470 threats leading to these declines is warranted, including reevaluation of the effectiveness or management
5471 techniques across the Northern Spotted Owl range in California.

5472 **Predation**

5473 Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-
5474 tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The
5475 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted
5476 Owls is not a threat to the population. In the case of documented Barred Owl aggression toward
5477 Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented
5478 mortalities were due to territorial aggression. Given that predation is not considered to be a major
5479 threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly
5480 manage predation issues.

5481 **Competition**

5482 Over the last several decades, Barred Owls have gradually moved further into the range of the Northern
5483 Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been
5484 present the longest (British Columbia and Washington), with fewer detections made in the southern
5485 edge of the range (California) where they have been present for a shorter duration. Currently, Barred
5486 Owls have been documented in all portions of the Northern Spotted Owl range throughout California,
5487 though densities of Barred Owls are unknown.

5488 Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to
5489 the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most
5490 important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat

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5491 and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong
5492 indication that the two species can coexist over time, sharing the same habitat and prey-base, because
5493 there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and
5494 not by Barred Owls.

5495 Public workshops held by the USFWS have resulted in four published and one unpublished meta-
5496 analyses since 1994 to assess population parameters, such as abundance, trend, and survival. These
5497 analyses show that in areas where Barred Owls are present, the decline in Northern Spotted Owl
5498 abundance has been steeper than where the Barred Owl was absent. Declines have been more
5499 prevalent where Barred Owls density was greatest. Northern Spotted Owl adult survival has declined in
5500 a majority of the range where Barred Owls were present, with a more gradual decline noted in California
5501 largely attributed to the relatively more recent Barred Owl expansion into this portion of the range.
5502 Presence of Barred Owls in or near Northern Spotted Owl territories is also thought to negatively impact
5503 fecundity, survival, and occupancy of Northern Spotted Owls.

5504 Experimental studies to remove Barred Owls conducted in California demonstrated that Northern
5505 Spotted Owl occupancy decreases with Barred Owl presence and increases with Barred Owl removal,
5506 suggesting that Barred Owls are displacing Northern Spotted Owls from their territories, forcing them
5507 into lower quality breeding and foraging habitat, and that Barred Owl removal encourages Northern
5508 Spotted Owl recolonization.

5509 Given the severity of impacts and the quick range expansion into California, the invasive Barred Owl is
5510 considered one of the major threats to Northern Spotted Owl populations in California. More research is
5511 needed to assess Northern Spotted Owl site occupancy, reproduction, and survival in the face of Barred
5512 Owl presence, including the and following implementation of experimental removal of Barred Owls.
5513 Exotic and invasive species control is analogous to wildland fire control in that the longer the delay in
5514 responding with countermeasures, the larger the outbreak becomes, making containment exponentially
5515 more difficult to obtain with the passage of time. Resource partitioning between the two species also
5516 needs further investigations. Therefore, operational Barred Owl control should be instituted as soon as
5517 possible. In addition, given the emotional response of some of the public and policy makers to the lethal
5518 take of Barred Owls, it is essential that outreach be conducted on the threat of invasive Barred Owls to
5519 Northern Spotted Owls and other wildlife, and the role of science in conservation.

Comment [JEH23]: Does it? Action is needed more than additional studies.

5520 Disease

5521 Several studies indicate that raptors, including Spotted Owls, may be impacted at some level by disease
5522 and insect infestations (e.g., West Nile Virus, avian influenza, avian malaria, Leucocytozoonosis, fly/~~mite~~
5523 ~~tick~~ infestations). The 2011 Northern Spotted Owl Revised Recovery Plan recognizes that disease threat
5524 is unknown, but may significantly impact owls. Disease occurrence in Northern Spotted Owls is likely
5525 under-reported because owls tend to inhabit remote areas and, therefore, there is a small likelihood of
5526 carcass recovery for testing. Disease may be a significant threat to Northern Spotted Owls, but more
5527 research is needed to better understand prevalence and magnitude of impacts in owl populations in
5528 California.

Comment [JEH24]: No other mention of mite in this document, so don't "mite" include in summary here.

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5529 **Other Natural Events or Human-related Activities**

5530 *Precipitation and Temperature Changes*

5531 Most climate projection scenarios agree that the forests in the Northern Spotted Owl’s range will have
5532 wetter winters and early-springs, colder winters in some areas, hotter/drier summers, and increased
5533 frequency and intensity of disturbance events. According to many climate projections, the frequency
5534 and duration of extreme climatic events, such as heat waves, wildfire and heavy rain or snow will
5535 increase over time. Vulnerability to disturbance, such as wildfire, disease, and insect outbreaks, is
5536 expected to increase in most forests in the Northwest and may change forest composition and structure
5537 depending on changes to climate. Climate modeling studies agree that forest wildfire occurrence and
5538 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced
5539 snowpack, earlier spring snowmelts, and longer drier summers.

5540 Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These
5541 studies indicate that winter precipitation is closely associated with a decrease in survival and
5542 recruitment; population growth was positively associated with wetter conditions during the growing
5543 season (May through October) and negatively associated with cold/wet winters and nesting seasons,
5544 and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction
5545 increased with late nesting season precipitation and decreased with warm temperatures; and owls may
5546 be more sensitive to changes in spring time climatic events. Higher summer temperatures could also
5547 result in more heat-stress during reproductive periods.

5548 It is clear that climate change is occurring within the Northern Spotted Owl’s entire range, with many
5549 climate projections forecasting steady changes in the future. Climate change studies predict future
5550 conditions that may negatively impact owls, such as wet and cold springs, more frequent and severe
5551 summer heat waves, decreased fog along the coast, shifts in forest species composition, and increased
5552 frequency of severe wildfire events. Yet in some instances projected future conditions, such as increased
5553 frequency of low to moderate severity fires and expansion of suitable owl habitat, may be favorable to
5554 the Spotted Owl in the long-term. In California, current rates of temperature and precipitation change
5555 predict hotter drier conditions in some areas of the owl’s range and wetter colder conditions in other
5556 areas of the range. Looking at past precipitation and temperature trends, drying trends across most of
5557 the range coupled with warmer winters and cooler summers in the interior and cooler winters and
5558 warmer summers along the coast may play a role in both owl and prey population dynamics. More
5559 research is needed to assess the extent of these climate impacts on survival, population growth, and
5560 reproductive rates of Northern Spotted Owls in California, and to determine if negative impacts of
5561 climate change outweigh the positive ones.

5562 Climate change will likely impact the Northern Spotted Owl in California, but the degree to which it is a
5563 threat to the species continued existence in the short- or long -term needs further investigation. During
5564 long-term landscape planning related to Northern Spotted Owls and their habitat, potential climate
5565 change impacts should be analyzed and incorporated.

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5566 *Recreational Activity*

5567 Relatively few studies have been conducted on the impact of recreational activity on Northern Spotted
5568 Owls. A few studies suggest that stress levels increase in individual Northern Spotted Owls when
5569 exposed to motorcycle activities, timber harvest activities, and presence of hikers. It is clear recreational
5570 activities impact Northern Spotted Owls to some extent, but the level to which these activities may
5571 impact owls has yet to be determined. It is unlikely anthropogenic stress events associated with
5572 recreation will impact Northern Spotted Owl reproduction and survival to any great extent, though
5573 further research is warranted.

5574 *Loss of Genetic Variation*

5575 Loss of genetic variation is not considered to be a major threat to Northern Spotted Owls at this time.
5576 Some recent studies provide evidence that a population bottleneck may have occurred within the last
5577 few decades across the range of the Northern Spotted Owl; though no effect was documented for
5578 Northwest California.

5579 **Management Recommendations**

5580
5581 The goal of the Department is to secure recovery and long-term survival of the Northern Spotted Owl
5582 across their historic range. The Department has evaluated existing management measures and has
5583 identified the following management recommendations, listed in no particular order, as necessary to
5584 help achieve the aforementioned goal. Many of these recommendations are adapted from the USFWS
5585 Northern Spotted Owl Recovery Plan (USFWS 2011a) and are based on the best available scientific
5586 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where
5587 applicable. As new information becomes available, recommendations may be further refined.

5588 Planning and Timber Practices

- 5589 1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is
5590 consistent with the recovery of the species (see RA14).
- 5591 2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-
5592 range planning, setting priorities for scientific research and investigations, and/or when making
5593 major decisions affecting the Northern Spotted Owl (see RA5).
- 5594 3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative
5595 opportunities for nonfederal landowners to engage in management strategies (see RA15).
- 5596 4. Consider long-term maintenance of local forest management infrastructure as a priority in
5597 planning and land management decisions (see RA16).

Comment [JEH25]: And NTMPs?, USFWS likes them.

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- 5598 5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and
5599 contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of
5600 Northern Spotted Owls (see RA21), and Rules that conserve existing owl sites and high quality
5601 habitat (see RA10).
- 5602 6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential
5603 recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in
5604 California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration,
5605 HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
- 5606 7. Improve thorough documentation of harvest prescription methods within timber harvest plans
5607 and a rigorous evaluation of post-harvest levels of foraging, nesting, and roosting habitat.
- 5608 8. Evaluate the effects of silvicultural practices on important prey species (e.g., flying squirrel,
5609 woodrat) and their habitat.
- 5610 Population Trend and Demographic Parameters
- 5611 9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if
5612 the California population is decreasing, stationary or increasing (see RA2).
- 5613 10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy
5614 across its California range (see RA3).
- 5615 11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival,
5616 population growth and reproductive rates of Northern Spotted Owls in California, and
5617 determine if negative impacts of climate change outweigh the positive ones.
- 5618 Habitat
- 5619 12. Manage younger and overstocked Northern Spotted Owl habitat in a way that accelerates the
5620 development of structural complexity and biological diversity that benefits Spotted Owl (see
5621 RA6)
- 5622 13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl
5623 habitat) while allowing for other threats, such as wildfire and insects, to be addressed by
5624 restoration management actions (see RA32).
- 5625 14. Conserve Northern Spotted Owl sites and high value habitat to provide additional demographic
5626 support to population dynamics (see RA10).
- 5627 15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to
5628 inform decisions concerning the possible development of habitat conservation networks in
5629 California (see RA4).

Comment [JEH26]: Also, need to Develop a mechanism (FPRs?) to regulate, manage, and monitor hack and squirt and other hardwood control measures that are sometimes large scale and detrimental to Northern Spotted Owls.

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- 5630 16. Assess habitat requirements for, and barriers to, dispersal in California through research on
5631 Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and
5632 availability, and habitat modeling.
- 5633 17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath
5634 Province) to assist evaluating landscape-level issues in the Provinces in California, including
5635 monitoring and adaptive management actions (see RA7 and RA9).
- 5636 Wildfire
- 5637 18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).
- 5638 19. Retain large, dense patches of forests embedded in a matrix with reduced stand densities to
5639 limit the potential for stand-replacement fire and competitive pressure on old trees.
- 5640 20. Conduct experiments to better understand how vegetation management treatments (e.g.,
5641 thinning, restoration projects, prescribed fire, etc.) influence the development of Northern
5642 Spotted Owl habitat, prey abundance and distribution, and demographic performance (see
5643 RA11).
- 5644 a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in
5645 use of burned areas for foraging warrants additional research on long-term use of
5646 burned areas post-fire.
- 5647 21. Gather information on the effect of historical fire suppression and current fire regimes on owl
5648 habitat, especially on the quality of habitat as assessed through demographic rates at individual
5649 owl territories.
- 5650 22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of
5651 Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.
- 5652 23. Develop a process for evaluating the likely effects of post-fire management activities, such as
5653 salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate
5654 this process into post-fire management decisions.
- 5655 24. Concentrate pre- and post-fire silvicultural activities on conserving and restoring habitat
5656 elements that take a long time to develop, such as large trees, medium and large snags, downed
5657 wood (see RA12).
- 5658 Barred Owl
- 5659 25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy,
5660 reproduction, and survival in California (see RA23).

Comment [JEH27]: Implement active management to restore forest resiliency to fire and to reduce losses of nesting and roosting habitat to wildfire.

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- 5661 | 26. Promote ~~experimental~~ removal of Barred Owls within Northern Spotted Owl range, and if lethal
5662 | removal is deemed a ~~long-term management~~ useful tool to manage negative effects of Barred
5663 | Owls, explore methods for implementation within California (see RA22, RA28, RA29, and RA30).
- 5664 | 27. Investigate ~~the potential for~~ resource partitioning of sympatric Barred Owls and Northern
5665 | Spotted Owls (see RA26).
- 5666 | 28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted
5667 | Owl interactions.
- 5668 | a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by
5669 | the presence or absence of Barred Owls, but other unknown factors may also play a
5670 | role.
- 5671 | Disease and Contaminants
- 5672 | 29. Monitor prevalence and extent of sudden oak death within the Northern Spotted Owl range in
5673 | California, and ~~address as appropriate~~ implement control measures where feasible (see RA17).
- 5674 | 30. Investigate the potential influences of sudden oak death on Northern Spotted Owl habitat,
5675 | occupancy, and prey species abundance over the short- and long-term.
- 5676 | 31. Expand assessment and active mitigation of the impacts of marijuana cultivation (both illegal
5677 | and legal) on the Northern Spotted Owl and their habitat.
- 5678 | a. The watersheds analyzed to date comprise only 4% of the Northern Spotted Owl range.
5679 | Uncertainties in the dataset analyzed make it likely that the density of legal cultivation
5680 | sites is higher than reported in the analysis. In addition, given the measured density of
5681 | cultivation sites within Humboldt, Trinity and Mendocino counties potential impact of
5682 | marijuana cultivation sites on spotted owl habitat should be evaluated further.
- 5683 | b. Impacts of illegal cultivation to Northern Spotted Owls (e.g., habitat loss, exposure to
5684 | toxins such and rodenticides) are largely unknown. Recent studies on anticoagulant
5685 | exposure in fisher suggests some unknown impact to the owl since prey-base is shared
5686 | between the two species.
- 5687 | 32. Monitor prevalence of avian diseases (e.g., West Nile Virus, avian flu, *Plasmodium* spp.) in the
5688 | Northern Spotted Owl population, and address as appropriate (see RA17).
- 5689 | 33. Investigate the extent of stress induced impacts on Northern Spotted Owl reproduction and
5690 | survival due to recreational activities (e.g., hiking, off-road vehicular use).

Comment [JEH28]: The Jury is already in, lethal removal works very well. See GD and Hoopa results.

Comment [JEH29]: Lethal removal might also be a very good short-term tool, while other solutions can be developed.

Comment [JEH30]: Also, Outreach to the public regarding the threat of invasive Barred owls to Northern Spotted Owls (see RA27) and other wildlife.

Listing Recommendation

[TO BE COMPLETED AFTER EXTERNAL PEER REVIEW]

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Protection Afforded by Listing

The following is a discussion of potential protection that could be afforded to the Northern Spotted Owl in California if listed under CESA. While the protections identified in this section would help to ensure the future conservation of Northern Spotted Owls, there are protections now in place that would continue if the owl were not listed under CESA. These include current protections afforded under the Northern Spotted Owl federal status, protections afforded under the Forest Practice Rules, coverage of the owl under HCPs and NCCPs, current CEQA requirements, and existing laws and regulations that make it illegal under State law to take owls in California.

It is the policy of the Department to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052.). The conservation, protection, and enhancement of listed species and their habitat is of statewide concern (Fish & G. Code, § 2051(c)). CESA defines “take” as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. (Id. , § 86). Any person violating the take prohibition would be punishable under State law. When take is authorized through an incidental take permit, the impacts of the take must be minimized and fully mitigated, among other requirements.

Increased protection of Northern Spotted Owl following listing would occur with required public agency environmental review under CEQA. CEQA requires affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, rare, and threatened species. Where significant impacts are identified under CEQA, the Department expects project-specific required avoidance, minimization, and mitigation measures will also benefit the species.

CEQA would require analysis of potential impacts to Northern Spotted Owl regardless of listing status under CESA. In common practice, potential impacts to listed species is examined more closely in CEQA documents than potential impacts to unlisted species. State listing, in this respect, and required consultation with the Department during state and local agency environmental review under CEQA, is also expected to benefit the species in terms of related impacts for individual projects that might otherwise occur absent listing.

Without listing, Northern Spotted Owl take for research purposes is allowed via a Scientific Collecting Permit, and federal ESA 10a(1)(a). With listing, a state research Memoranda of Understanding (MOU) would also be required (Fish & G. Code, § 2081, subd. (a)). The added oversight allowed from MOU process is expected to benefit the species in terms of added coordination and research design, but will not likely add any additional protection.

In listing the Northern Spotted Owl under CESA, the Department would expect an increased level of coordination among public agencies, such as USFS, CAL FIRE, and the USFWS, and with private timber companies, increased level of Department involvement in the THP review and approval process, more regular and thorough acquisition of data, and a reevaluation of current management practices for the species. In addition, if the Northern Spotted Owl is listed under CESA, the likelihood that land and

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5731 resource management agencies will allocate funds towards protection and recovery actions may
5732 increase.

5733 **Economic Considerations**

5734
5735 The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).
5736

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6554 **Appendix 1. Forest Practice Rule definitions of silvicultural prescriptions.**

6555 The Forest Practice Rules differentiate silvicultural methods into four silvicultural categories. These
6556 silvicultural categories include even-aged management, uneven-aged management, intermediate
6557 treatments, and special prescriptions.

6558
6559 An Alternative silvicultural prescription can be included in a timber harvest plan when an alternative
6560 regeneration method or intermediate treatment is more effective or more feasible than any of the
6561 standard silvicultural methods.

6562 6563 **Even-aged Management**

6564 Section 913.1 – Even-aged management are methods designed to replace a harvestable stand with well-
6565 spaced growing trees of commercial species.

6566 6567 Clearcutting

6568 Section 913.1(b) – Clearcutting regeneration method involves the removal of a stand in one
6569 harvest.

6570 6571 Seed Tree

6572 Section 913.1(c) – The seed tree regeneration method involves the removal of a stand in one
6573 harvest except for well distributed seed trees of desired species which are left singly or in
6574 groups to restock the harvested area.

6575 6576 Seed Tree Seed Step

6577 Section 913.1(c)(1) – Seed Tree Seed Step: The seed tree seed step is the regeneration
6578 step and shall meet the following requirements:

6579 (A) Retention of at least the following basal area of seed trees per acre which are 18
6580 inches dbh or greater:

- 6581 1. Fifteen square feet basal area on site I, II and III lands and
- 6582 2. Twelve square feet basal area on site IV and V lands.

6583 The seed trees must be of full crown, capable of seed production and representative of
6584 the best phenotypes available in the preharvest stand.

6585 (B) No point within the logged area shall be more than 150 feet from a seed tree.

6586 (C) Seed tree species and site preparation measures shall be specified in the plan by
6587 the RPF.

6588 (D) Seed trees shall be marked by or under the supervision of an RPF prior to felling
6589 operations.

6590 (E) If natural regeneration is inadequate within two years after the first August
6591 following completion of timber operations, seed trees may be harvested and
6592 artificial regeneration shall be used to meet the requirements of Section
6593 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)].

6594 6595 Seed Tree Removal Step

6596 Section 913.1(c)(2) – No more than 15 predominant trees per acre may be removed in
6597 the seed tree removal step. Not more than 50 sq. ft. of basal area of predominant trees
6598 per acre may be removed in the seed tree removal step. The seed tree removal step
6599 may be utilized when the regeneration present exceeds the minimum stocking
6600 requirements set forth in Section 912.7(b)(1)[932.7(b)(1), 952.7(b)(1)].

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Shelterwood

Section 913.1(d) – The shelterwood regeneration method reproduces a stand via a series of harvests (preparatory, seed, and removal). The preparatory step is utilized to improve the crown development, seed production capacity and wind firmness of designated seed trees. The seed step is utilized to promote natural reproduction from seed. The removal step is utilized when a fully stocked stand of reproduction has become established, and this step includes the removal of the protective overstory trees. The shelterwood regeneration method is normally utilized when some shade canopy is considered desirable for the establishment of regeneration.

Shelterwood Preparatory Step

Section 913.1(d)(1) – The shelterwood preparatory step shall meet the following minimum standards:

(A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.

1. Thirty square feet basal area on site I, II and III lands and

2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 100 ft. from a seed tree.

(C) Seed tree species shall be specified in the plan by the RPF.

(D) At least 125 sq. ft. of basal area per acre on Site I lands, and 75 sq. ft. of basal area per acre on Site II and III lands and 50 sq. ft. of basal area per acre on site IV and V lands shall be retained.

(E) The minimum stocking standards of 14 CCR § 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)] shall be met immediately upon completion of operations.

Shelterwood Seed Step

Section 913.1(d)(2) – The shelterwood seed step is the regeneration step and shall meet the following standards:

(A) At least the following basal area of seed trees per acre which are 18 inches dbh or greater shall be retained.

1. Thirty square feet basal area on site I, II and III lands and

2. Twenty four square feet basal area on site IV and V lands.

The seed trees must be of full crown, capable of seed production and representative of the best phenotypes available in the preharvest stand.

(B) No point within the logged area shall be more than 100 ft. from a seed tree.

(C) Seed tree species and site preparation measures shall be specified in the plan by the RPF.

(D) Seed trees shall be marked by or under the supervision of an RPF prior to felling operations.

(E) If natural regeneration is inadequate within two years after the first August following completion of timber operations, seed trees may be harvested and artificial regeneration shall be used to meet the requirements of 14 CCR § 912.7(b)(1), [932.7(b)(1), 952.7(b)(1)].

(F) In the absence of a Sustained Yield Plan, to maintain and improve tree species diversity, genetic material and seed production, trees of each native commercial species where present at the time of harvest shall be retained after harvest.

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These leave trees shall be representative of the best phenotypes available in the preharvest stand. The RPF may propose and the Director may agree to a species specific plan in the THP which protects existing regeneration or provides for regeneration in-lieu of retaining trees.

Shelterwood Removal Step [Coast only]

Section 933.1(d)(3) - The shelterwood removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 912.7(b)(1). Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used once in the life of the stand. Regeneration shall not be harvested during the shelterwood removal step unless the trees are dead, dying or diseased or substantially damaged by timber operations. The minimum stocking standards of Section 912.7(b)(1) shall be met immediately upon completion of operations. The size limitations, and separation (spacing) by logical logging unit requirements, of Section 913.1(a) are applicable unless the post-harvest stand, regardless of average diameter, meets the stocking standards of Section 913.3(a)(1)(A) or (B)]. Not more than 32 predominant trees per acre may be removed in the shelterwood removal step. Not more than 100 square feet of basal area of predominant trees per acre may be removed in the shelterwood removal step.

Shelterwood Removal Step [Northern and Southern]

The shelterwood removal step may be utilized when the regeneration present exceeds the minimum stocking requirements set forth in Section 932.7(b)(1) [952.7(b)(1)]. Unless otherwise agreed to by the Director, the Shelterwood removal shall only be used once in the life of the stand. Regeneration shall not be harvested during the shelterwood removal step unless the trees are dead, dying or diseased or substantially damaged by timber operations. The minimum stocking standards of Section 932.7(b)(1) [952.7(b)(1)] shall be met immediately upon completion of operations. If the extent and intensity of the ground disturbance caused by the harvest is essentially the same as would have been caused by a clearcut or will cause adverse cumulative effects on wildlife as determined by the RPF or Director, the size limitations, and separation (spacing) by logical logging unit requirements of Section 933.1(a) [953.1(a)] are applicable unless the post-harvest stand, regardless of average diameter, meets area stocking standards of Section 933.3(a)(1)(A) or (B) [953.3(a)(1)(A) or (B)].

Uneven-aged Management

Sections 895.1 and 4593.2(c) – Uneven-aged management means the management of a specific forest, with the goal of establishing a well-stocked stand of various age classes and which permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop. Also defined in the SAF Dictionary of Forestry as “a stand of trees of three or more distinct age classes, either intimately mixed or in small groups”.

Selection/Group Selection

Section 913.2(a) – Under the selection regeneration method, the trees are removed individually or in small groups sized from 0.25 to 2.5 acres.

Transition

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Section 913.2(b) – The transition method may be used to develop an unevenaged stand from a stand that currently has an unbalanced irregular or evenaged structure. The transition method involves the removal of trees individually or in small groups from irregular or evenaged stands to create a balanced stand structure and to obtain natural reproduction.

Intermediate Treatments

Section 895.1 – Intermediate treatments means harvests conducted to modify or guide the development of an existing stand of trees, but not to replace (regenerate) the stand with a new one. The treatments involve the removal of trees to allow expansion of the crowns and root systems.

Commercial Thinning

Section 913.3(a) – Commercial thinning is the removal of trees in a young-growth stand maintain or increase average stand diameter of the residual crop trees, promote timber growth and/or improve forest health.

Sanitation-Salvage

Section 913.3(b) – Sanitation is the removal of insect attacked or diseased trees in order to maintain or improve the health of the stand. Salvage is the removal of only those trees which are dead, dying, or deteriorating, because of damage from fire, wind, insects, disease, flood or other injurious agent.

Special Prescriptions

Section 913.4 – Special Prescriptions are special harvesting methods which are appropriate under certain conditions.

Special Treatment Area

Sections 895.1 – Special Treatment Areas are specific locations which contain one or more of the following significant resource features which may be at risk during timber operations:

- a. Within 200 feet of the watercourse transition line of federal or state designated wild and scenic rivers;
- b. Within 200 feet of national, state, regional, county or municipal park boundaries;
- c. Key habitat areas of federal or state designated threatened, rare or endangered species;
- d. Coastal Commission special treatment areas;
- e. Within 200 feet of state designated scenic highways or within scenic corridors established pursuant to Article 2.5 (commencing with Section 260) of Chapter 2 of Division 1 and Section 154 of Chap. 1 of Div. 1 of the Streets and Highways Code.

Section 913.4(a) – Special consideration in Special Treatment Areas shall be given to selection of a regeneration method or intermediate treatment compatible with the objectives for which the special area was established. Such areas shall be identified in the plan. To assure the integrity of legally designated historical and archaeological sites and legally designated ecological reserves, and that the objectives of the special treatment areas are met, the RPF and the Director may agree, after on-the-ground inspection, if requested by either party, on specific silvicultural and logging practices to protect such areas. The Director shall notify affected agencies or groups with expertise in the resource involved in the special treatment area of any such areas located during the THP review process.

Rehabilitation

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6744 Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial
6745 timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7)
6746 prior to any timber operations on such lands, an area may be harvested provided it is restocked
6747 in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be
6748 included in the THP. The regeneration plan shall include site preparation, method of
6749 regeneration, and other information appropriate to evaluate the plan.
6750
6751 Fuelbreak/Defensible Space
6752 Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a
6753 shaded fuel break or defensible space in an area to reduce the potential for wildfires and the
6754 damage they might cause.
6755
6756 Variable Retention
6757 Section 913.4(d) - Variable retention is an approach to harvesting based on the retention of
6758 structural elements or biological legacies (trees, snags, logs, etc.) from the pre-harvest stand for
6759 integration into the post-harvest stand to achieve various ecological, social and geomorphic
6760 objectives.
6761
6762 Conversion
6763 Section 1100 – within non-timberland production zone (TPZ) timberland, transforming
6764 timberland to a nontimber growing use through timber operations.
6765
6766 **Alternative Prescription**
6767 A written analysis of preharvest and postharvest timber stand conditions and a description of the
6768 silvicultural practices and systems to be used in lieu of the standard methods. An Alternative silvicultural
6769 prescription can be included in a timber harvest plan when an alternative regeneration method or
6770 intermediate treatment is more effective or more feasible than any of the standard silvicultural
6771 methods.
6772 Section 913.6 – When an Alternative method is used, the plan must include a statement of which
6773 silvicultural method in the current District rules is most nearly appropriate or feasible and an
6774 explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how
6775 the proposed alternative prescription will differ from the most nearly feasible method in terms of
6776 securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in
6777 terms of fire, insect and disease protection.
6778
6779
6780 NonTimberland Area
6781 Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land,
6782 other than land owned by the federal government and land designated by the board as experimental
6783 forest land, which is available for, and capable of, growing a crop of trees of a commercial species used
6784 to produce lumber and other forest products, including Christmas trees.
6785
6786 Road Right of Way
6787 No strict definition
6788
6789

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6790 **Appendix 2: Forest Practice Rule definitions regarding Northern Spotted Owl or**
6791 **their habitat**

6792 **Activity Center (AC)** means a known northern Spotted Owl site documented from detections, pursuant
6793 to the USFWS document “Protocol For Surveying Proposed Management Activities That May Impact
6794 Northern Spotted Owls” revised March 17, 1992.

6795 (a) An AC is established by:

6796 (1) Resident Single Status is established by:

6797 (A) The presence or response of a single owl within the same general area on three or
6798 more occasions within a breeding season, with no response by an owl of the opposite
6799 sex after a complete survey;

6800 (B) Multiple responses over several years (i.e., two responses in year one and one
6801 response in year 2, from the same general area).

6802 (2) Pair Status Unknown is where the presence or response of two birds of the opposite sex is
6803 detected but pair status cannot be determined and where at least one member must meet the
6804 resident single requirements.

6805 (3) Pair Status wherein a male and female are heard and/or observed (either initially or through
6806 their movement) in proximity (less than one-quarter mile apart) to each other on the same visit;
6807 or a male takes a mouse to a female; or a female is detected on the nest; or one or both adults
6808 are observed with young.

6809 (4) Unoccupied Status where no responses have been obtained from a previously identified
6810 northern Spotted Owl activity center after 3 years of survey, barring other evidence to the
6811 contrary.

6812 An AC with unoccupied status will not be considered an AC when it has been evaluated and a
6813 determination made by the Director. The determination shall be based upon available information on
6814 survey history, habitat conditions within the home range, and changes to habitat that may have
6815 occurred since the northern Spotted Owl site was first identified.

6816 **Functional Foraging Habitat** is dependent upon the presence and availability of prey on the forest floor
6817 or in the canopy; presence of accessible perching limbs; and adjacency to stands with canopy closures
6818 >40%. Average stem diameter is usually >6" dbh for hardwoods and >11" dbh for conifers among
6819 dominants, and co-dominants, and the total overhead canopy closure, including intermediate trees is at
6820 least 40%. Where overall canopy closure is >80%, foraging habitat is limited to areas with ample flight
6821 space below limbs and among stems. Foraging habitat in smaller size classes and lower percentage
6822 canopy closures must be justified by local information.

6823 **Functional Nesting Habitat** means habitat with a dominant and co-dominant tree canopy closure of at
6824 least 40% and a total canopy (including dominant, co-dominant, and intermediates) of at least 60%.
6825 Usually the stand is distinctly multi-layered with an average stem diameter in dominant, and co-
6826 dominant conifers, and hardwoods >11" dbh. The stand usually consists of several tree species
6827 (including hardwoods) of mixed sizes. All nests, snags, down logs, and decadent trees shall also be
6828 considered as part of the habitat. Nesting substrates are provided by broken tops, cavities, or platforms

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6829 such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are
6830 known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with
6831 characteristics of topographic relief and aspect which alter microclimates.

6832 **Functional Roosting Habitat** during the territorial breeding season, consists of stands where
6833 average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers
6834 provide an average of at least 40% canopy closure but the stand can have a high degree of variability.
6835 Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for
6836 protection from various environmental conditions, including wind, heat, and precipitation.

6837 **Owl Habitat** means Type A, B, or C owl habitat or those areas with functional foraging habitat,
6838 functional nesting habitat, and functional roosting habitat which support the owl's biological needs for
6839 breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the
6840 functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls
6841 are known to occasionally inhabit less than optimal forest structure, local information can be used to
6842 justify the modification of functional habitat definitions.

6843 **Type A Owl Habitat** means timber stands that have as a minimum the following characteristics for
6844 live-tree structure:

- 6845 **1. Canopy layers:** The stand has two distinct tiers or is multi-layered with dominant
6846 conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for
6847 some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.
6848 **2. Canopy Closure:** The canopy closure of conifers greater than 120 ft. tall (or greater than
6849 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
6850 and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.
6851 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than nine
6852 stems per acre and not less than six stems per acre and includes a component of trees with sparse,
6853 broken, or dead tops.
6854 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6855 than 15 stems per acre and not less than 8 stems per acre.
6856 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
6857 than 50 stems per acre and not less than 20 stems per acre.
6858

6859 **Type B Owl Habitat** means timber stands that have as a minimum the following characteristics for
6860 live-tree structure:

- 6861 **1. Canopy Layers:** Moderately to strongly two-tiered or multi-layered with dominant
6862 conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some
6863 montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.
6864 **2. Canopy Closure:** The canopy closure of conifers greater than 100 ft. tall (or greater than
6865 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40%
6866 and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.
6867 **3. Large Trees:** The density of conifers greater than 35 in. dbh averages more than six

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6868 stems per acre and not less than two stems per acre.

6869 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6870 than 25 stems per acre and not less than 20 stems per acre.

6871 **5. Small Trees:** The density of conifers or hardwoods less than 18 in. dbh averages more
6872 than 50 stems per acre and not less than 20 stems per acre.

6873 **Type C Owl Habitat** means timber stands that have as a minimum the following characteristics for
6874 live-tree structure:

6875 **1. Canopy Layers:** Uniform to moderately layered with dominant conifers or hardwoods 50
6876 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.

6877 **2. Canopy Closure:** The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages
6878 greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is
6879 greater than 60%.

6880 **3. Large Trees:** The density of conifers greater than 35 inches dbh averages less than six
6881 stems per acre and may be absent.

6882 **4. Medium Trees:** The density of conifers or hardwoods 18 to 35 in. dbh averages more
6883 than 15 stems per acre, but may be absent.

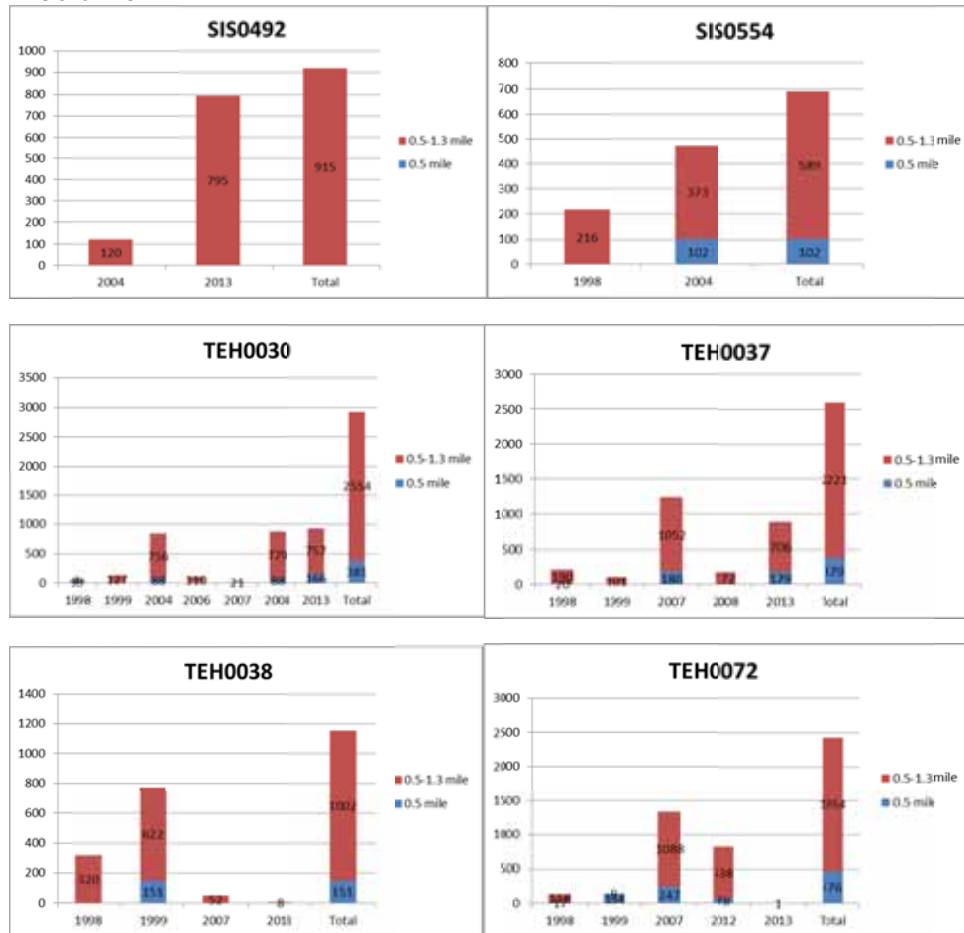
6884 **5. Small Trees:** The density of conifers or hardwoods less than 18 inches dbh averages
6885 more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the
6886 stand, including small, medium, and large trees is greater than 10 inches.

6887

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Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

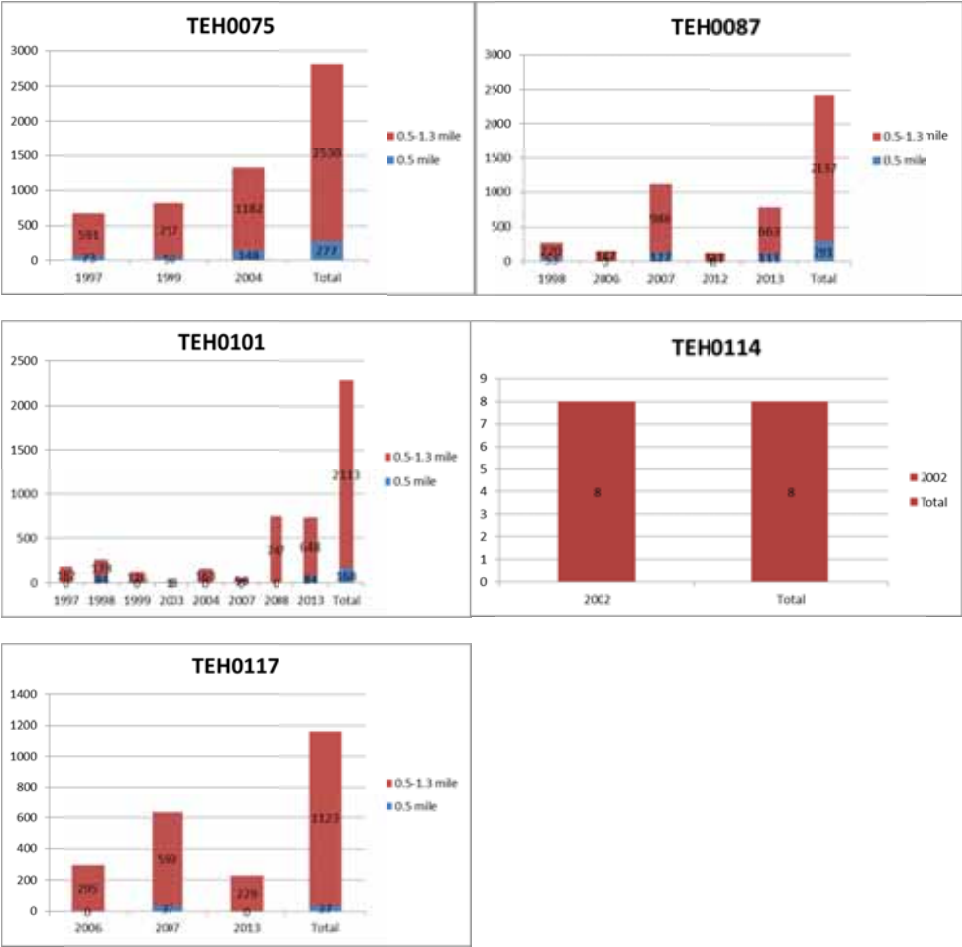
THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.



Comment [JEH34]: Does this include all or a subset of ACs?

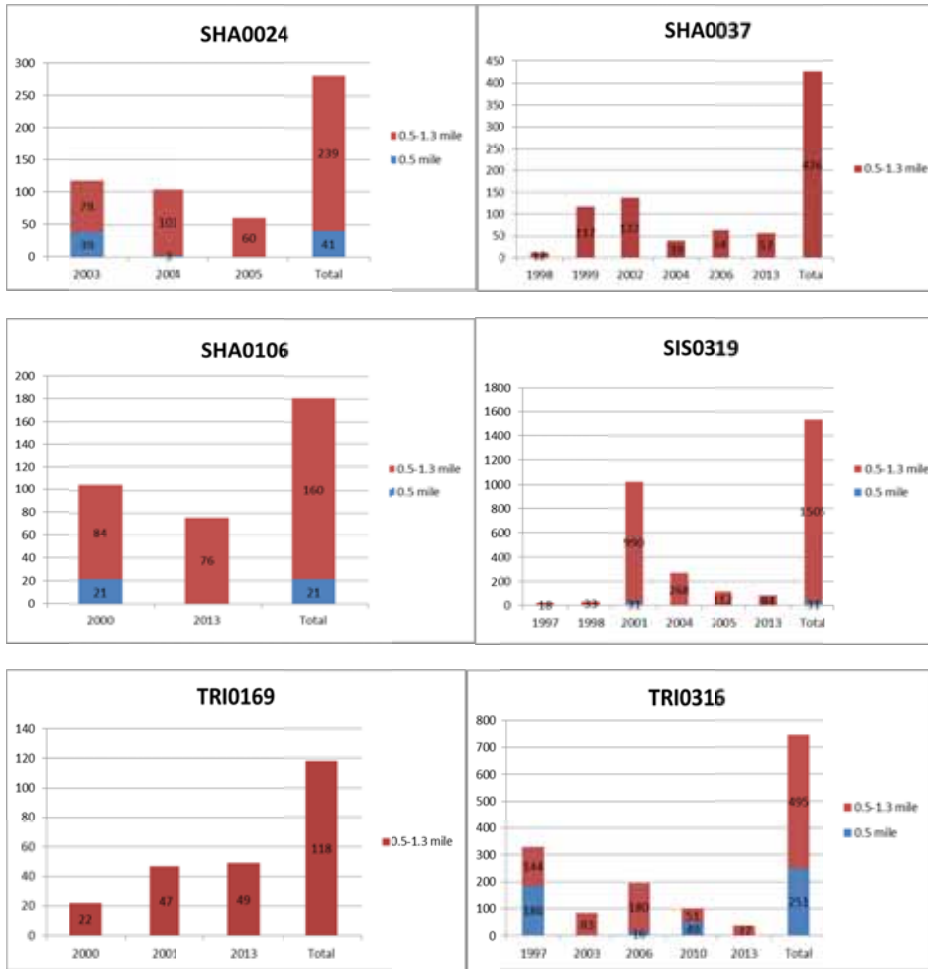
Comment [JEH35]: Coast and interior physiographic provinces? Appendix title needs improvement.

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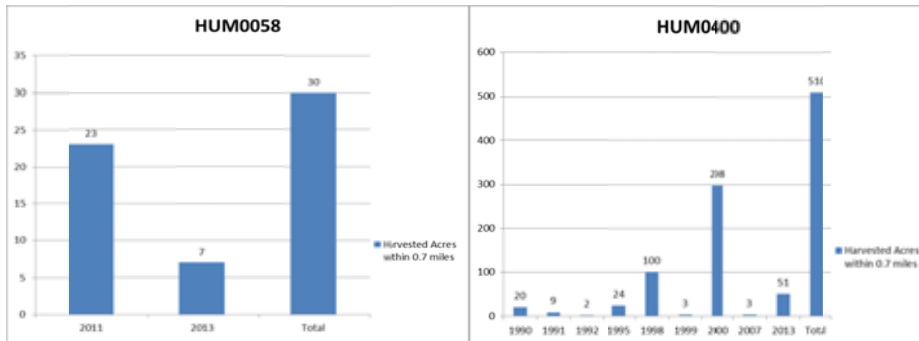
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6903 THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3
6904 mile of an AC

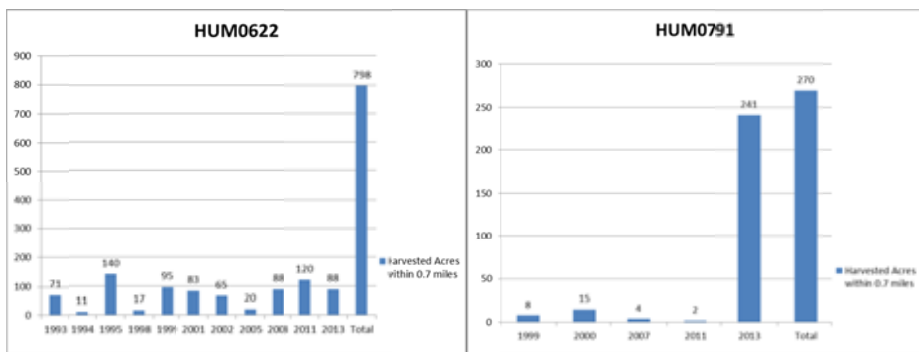


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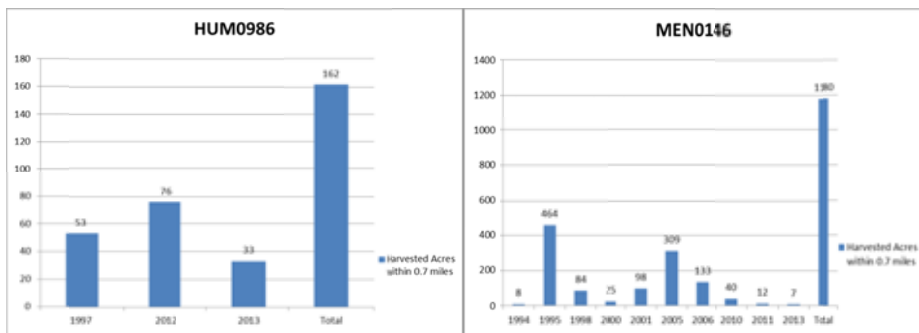
6909 THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



6909

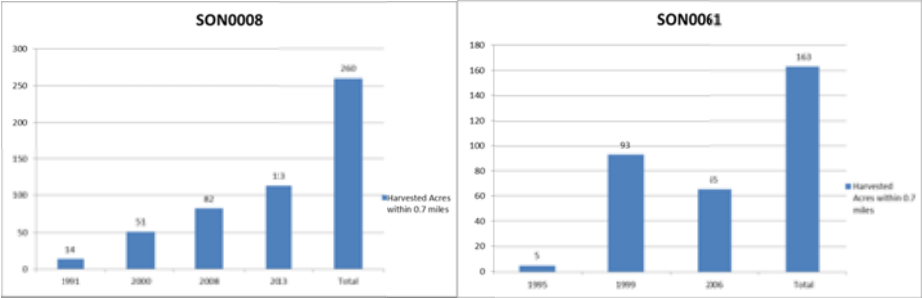
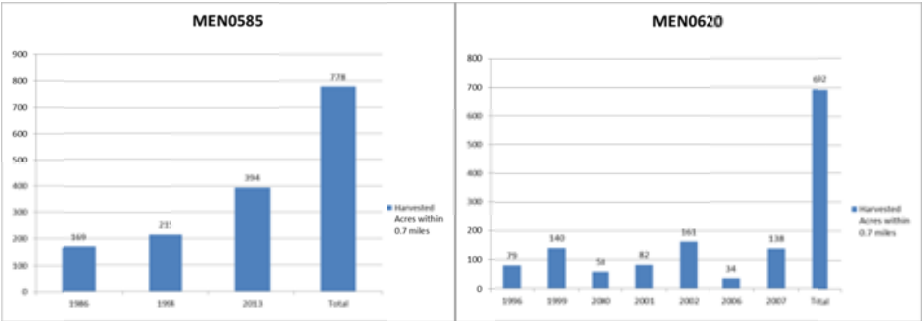
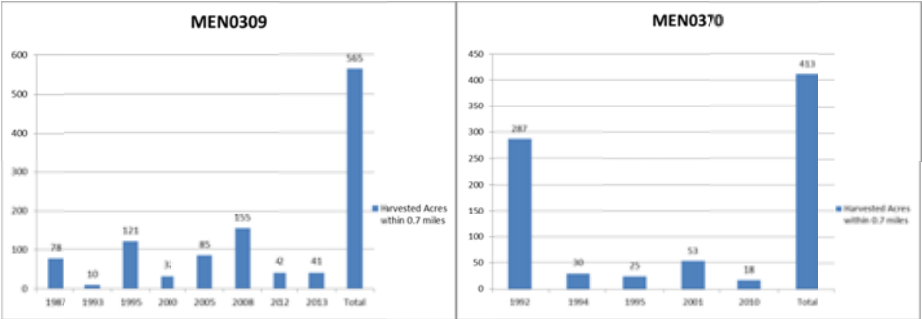


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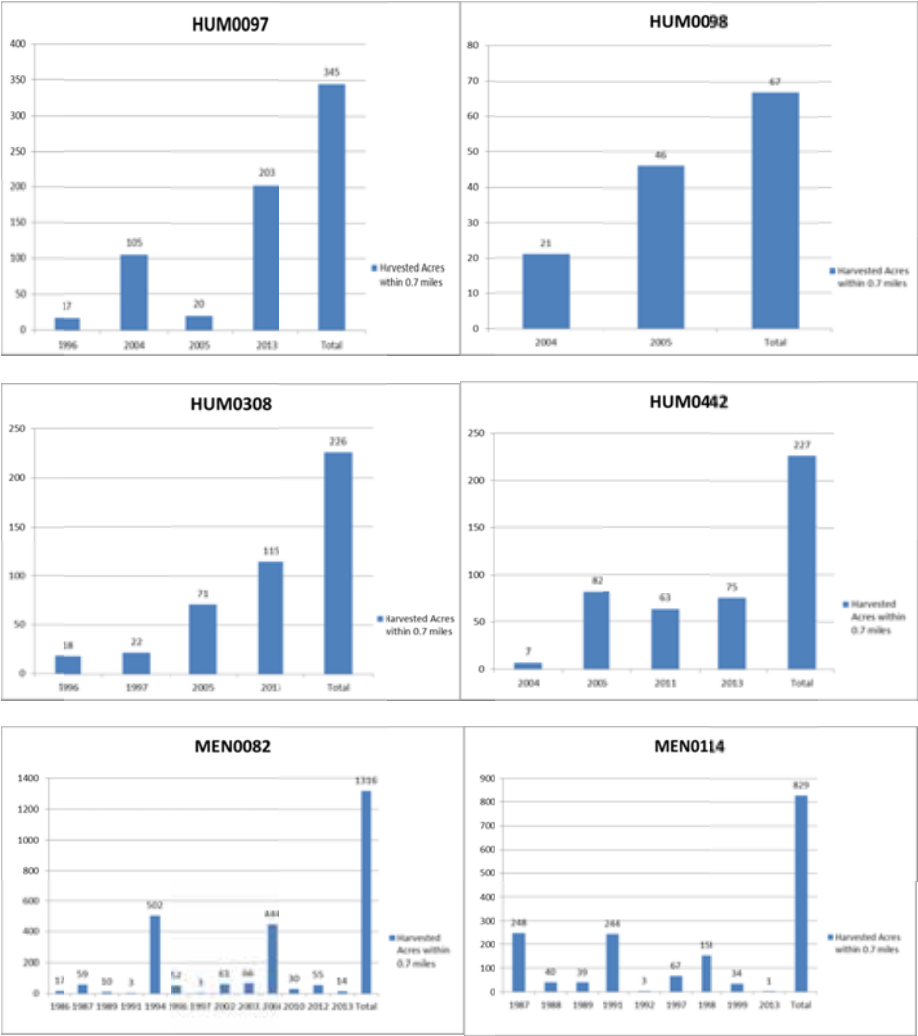
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6913 THP’s utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



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6922
6923

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6923	Appendix 4. List of Acronyms and Abbreviations	
6924		
6925	AC	Activity Center
6926	AMA	Adaptive Management Areas
6927	AR	Anticoagulant Rodenticides
6928	BLM	Bureau of Land Management
6929	Board	Board of Forestry and Fire Protection
6930	BO	Biological Opinion
6931	BOE	Board of Equalization
6932	BOF	State Board of Forestry and Fire Protection
6933	CA State Parks	California Department of Parks and Recreation
6934	CAL FIRE	California Department of Forestry and Fire Protection
6935	Caltrans	California Department of Transportation
6936	CBD	Center for Biological Diversity
6937	CD	Consistency Determination
6938	CEQA	California Environmental Quality Act
6939	CESA	California Endangered Species Act
6940	CCAA	Candidate Conservation Agreement with Assurances
6941	CDFW	California Department of Fish and Wildlife
6942	CI	Confidence Interval
6943	CNDDDB	California Natural Diversity Database
6944	Commission	Fish and Game Commission
6945	CPV	Canine Parvovirus
6946	CSA	Conservation Support Areas
6947	CWHR	California Wildlife Habitat Relationships
6948	DBH	Diameter at Breast Height
6949	DSA	Density Study Area
6950	Department	California Department of Fish and Wildlife
6951	EIR	Environmental Impact Report
6952	EPA	Environmental Protection Agency
6953	ESA	Federal Endangered Species Act
6954	FEIS	Final Environmental Impact Statement
6955	FRGP	Fisheries Restoration Grant Program
6956	FGS	Fruit Growers Supply Company
6957	FEMAT	Forest Ecosystem Management Assessment Team
6958	FIA	Forest Inventory Analysis
6959	FMP	Forest Management Plan
6960	FPA	Forest Practice Act
6961	FRI	Fire Return Interval
6962	FSC	Forest Stewardship Council
6963	GDR	Green Diamond Resource Company study area
6964	GDRC	Green Diamond Resource Company
6965	ITP	Incidental Take Permit
6966	ITS	Incidental Take Statement
6967	JDSF	Jackson Demonstration State Forest
6968	HCP	Habitat Conservation Plan
6969	HFP	Habitat Fitness Potential

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6970	HCVF	High Conservation Value Forests
6971	HUP	Hoopa Indian Reservation study area
6972	HRC	Humboldt Redwood Company
6973	LSA	Late-Successional Areas
6974	LSAA	Lake or Streambed Alteration Agreement
6975	LSR	Late-Successional Reserve
6976	MBF	1,000 board-foot
6977	MIS	Management Indicator Species
6978	MMCA	Marbled Murrelet Conservation Areas
6979	MRC	Mendocino Redwood Company
6980	NCA	National Conservation Area
6981	NCCP	Natural Community Conservation Plan
6982	NIPF	Non-industrial private forest
6983	NPS	National Park Service
6984	NSO	Northern Spotted Owl
6985	NTMP	Nonindustrial Timber Management Plans
6986	NTO	Notice of Operations
6987	NWC	Northwest California study area
6988	NWFP	Northwest Forest Plan
6989	ORV	Off Road Vehicle
6990	PCB	Private Consulting Biologists
6991	PFT	Pacific Forest Trust
6992	PL	Pacific Lumber Company
6993	PRNS	Point Reyes National Seashore
6994	PSU	Primary Sampling Unit
6995	REF	Suppressed reproduction and growth
6996	RNSP	Redwood National and State Parks
6997	ROD	Record of Decision
6998	RPF	Registered Professional Foresters
6999	SEIS	Supplemental Environmental Impact Statement
7000	SHA	Safe Harbor Agreement
7001	SOMP	Spotted Owl Management Plans
7002	SOP	Spotted Owl Expert
7003	SORP	Spotted Owl Resource Plan
7004	SFI	Sustainable Forestry Initiative
7005	SP	State Park
7006	SPI	Sierra Pacific Industries
7007	TCP	Timberland Conservation Planning Program
7008	THP	Timber Harvest Plan
7009	TPZ	Timber Production Zone
7010	UCNRS	UC Natural Reserve System
7011	USFWS	U.S. Fish and Wildlife Service
7012	USFS	U.S. Forest Service
7013	USDA	United States Department of Agriculture
7014	USDI	United States Department of Interior
7015	USFS	United States Forest Service
7016	WCSA	Willow Creek Study Area
7017	WLPZ	Watercourse and Lake Protection Zones

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7018 WNV West Nile virus
7019