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.

R.J. Gutierrez, Ph.D.

John E. Hunter

Comments from Lowell V. Diller, Ph.D.

From:	Lowell Diller
To:	Clipperton, Neil@Wildlife
Cc:	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

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, section2074.6, 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.

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.

> 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, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.

> 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 such migratory nongame bird except as provided by rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory Treaty Act.

California Board of Forestry and Fire Protection

The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire Protection (CAL FIRE) have designated Northern Spotted Owl as a “Sensitive Species” as identified in the California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules). These sections also define Northern Spotted Owl -related terminology, including “activity center”, “Northern Spotted Owl breeding season”, and “Northern Spotted Owl Evaluation Area.” Specific requirements for the disclosure of information on Northern Spotted 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 sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and related activities, would be avoided according to the criteria for determining take avoidance found in Section 919.10. Other 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 nests through buffers and avoidance of sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the protections afforded to late successional forests, which are a component of Northern Spotted Owl habitat.

International Union for Conservation of Nature

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

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 2011~~a~~). 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,

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 km^2 (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).

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

Comment [LVD8]: 8.I 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.I 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.

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 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 ~~2~~3 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 ~~D~~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/km^2) 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/ km^2 of habitat) at 0.544 owls/km^2 (95% CI = 0.495-0.592) and 0.660 owls/km^2 (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km^2. 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/km^2±0.006, 0.351 owls/km2±0.011, and 0.313 owls/km^2±0.017 for Klamath, Korbel and Mad River regions respectively, with an overall mean density of 0.209 owls/km^2±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbel, 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 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, ... [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 cas ... [3]

Comment [LVD17]: 17.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 ... [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-c ... [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.

density estimate (i.e., naïve count without accounting for detection probabilities) of 0.17 owls/km^2 in the northern portion of their land in Humboldt County, and 0.78 owls/km^2 in southern portions. Sierra Pacific Industry reported 0.450 owls/km^2 between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km^2 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/km^2 of area surveyed (MRC 2014). Lastly, Humboldt Redwood Company (HRC) reported 1.22 occupied territories/km^2 and 2.23 owls/km^2 of area surveyed on their lands in Humboldt County (HRC 2013).

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.

Table 1. Population ~~D~~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 [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.

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 (*Glaucomys sabrinus*) 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 (*Neotoma fuscipes*) 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). A study in Humboldt and Del Norte counties of coastal California indicated that dusky-footed woodrats comprised 45% of the frequency and 74% of the prey biomass, but tree voles and flying squirrels were also important in the overall composition of the owl's diet (Diller et al. 2010). 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).

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.

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 owl's 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.

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

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. Given the known genetic exchange between these two subspecies, ~~T~~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. 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). Similar results have also been reported for a study in the coastal redwood region (Diller et al. 2010). Winter use of these areas was more pronounced in areas with 9-18 m^2/ha basal area (Irwin et al. 2013).

Home Range and Territoriality

Northern Spotted Owls are highly territorial. Territories, a core area of the entire home range including the nest and primary roosting areas, are actively defended using aggressive vocal displays, and even physical confrontations on the rare occasion (Courtney et al. 2004, Van Lanen et al. 2011). Because of their ~~high~~ strong territoriality, broadcast surveys are generally a very effective method for determining presence of resident 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~~ Home range, the total area utilized by an individual owl for all its life needs, varies 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).~~

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.

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 Kernal, and Adaptive Kernal) 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 forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference between breeding and nonbreeding seasons. The study showed core area size, annual home range and breeding home range size increased as amount of hard edge increased (Schilling et al. 2013). In their study site 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, with ranges being 3.5 times larger during the fall and winter months.

Home range of Northern Spotted Owls ~~may~~ commonly overlap with those of other neighboring owl pairs, ~~suggesting~~ indicating that the defended area (i.e., territory) is smaller than the area used for foraging (Forsman et al. 1984, Solis and Gutiérrez 1990, 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 (Zabel et al. 1995, Forsman et al. 2001). Woodrats provide twice or more the biomass of flying squirrels and, and can occur at high population densities (Hamm 1995, Hughes 2005) therefore are a more ~~energetically favorable~~ideal prey species, which likely explains the smaller home range in the owl's southern portion of the range (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). Forsman et al. (2015) attributes the larger winter home range to prey dynamics and exploratory excursions in search of better habitat.

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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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 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

Dispersal

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

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

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

Habitat Requirements

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

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 2011~~a~~). 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 Gutiérrez1990 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 Gutiérrez1999, Swindle et al. 1999, Weathers et al. 2001, Courtney et al. 2004, USFWS 2008a, USFWS 2011~~a~~).

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.”

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, Folliard et al. 2000, USFWS 2011a, Irwin et al. 2013).

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.

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, Diller et al. 2010, USFWS 2011~~a~~). 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 2011~~a~~).

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 (tress >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.

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.

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 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry 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.

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.

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 (Gutiérrez1996, 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, Diller et al. 2010).

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, Diller et al. 2010). 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 diameter[1] 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).

[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.

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 m^2/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 all. (*In press*) has been accepted by Condor so it becomes the latest

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 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.

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.

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 2011~~a~~; 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 2011~~a~~) 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 2011~~a~~) 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 2011~~a~~, 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 then 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.

~~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 2011~~a~~). ~~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 2011~~a~~, 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.

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

<u>California Klamath Province</u>

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 2011~~a~~) 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 2011~~a~~, 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

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

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

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

			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

<u>California Cascade Province</u>

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

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

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

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

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

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

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

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

Habitat Effects on Survival and Reproduction

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

In the most recent ~~broad demographic~~ meta-analysis of all eleven demographic study areas throughout the range of the Northern Spotted Owl (Figure 7) (~~Forsman et al. 2011~~Dugger et al. *In press*), 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).

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.

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.

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

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 change[2]) and the rates of survival and reproduction that influence λ (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005, Diller et al. 2010). The habitat characteristics that influence 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.

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 ≥40%, and overstory canopy coverage of ≥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 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 totally 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 a 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 notably 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 with roughly 50% to support highest fitness)	Variable but with greatest fitness with roughly equal amounts of older and young forests.	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	No effects on vital rates extended beyond 600m of the nest stand.	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 directly[c] but "other habitat" (which included nonhabitats) in juxtaposition with late seral habitat created habitat heterogeneity that had a positive influence on habitat fitness	Early seral stands were important to create habitat heterogeneity that had a positive influence on habitat fitness	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]	Both apparent survival and reproductive output increased with increasing edge between spotted owl habitat and other vegetation types	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

[a]Size 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.

[b]Size 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.

[c]Franklin 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 proportions of each, they indicated that “other habitats” were created naturally by fire, edaphic and topographic factors and through human-caused (logging) disturbance.

[d]Edge 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.

[e]Franklin 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 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 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 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 m^2/ha) had higher reproducti~~on~~ve success; however sites with higher reproducti~~on~~ve 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 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 2011~~a~~). 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 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 2011~~a~~). 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.*”

~~**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

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.

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 form 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.

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 2011~~a~~). 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 2011~~a~~).

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~~a~~).

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 initiated in 1990 entirely on private land (i.e., Green Diamond Resource Company), one initiated in 1992 on the Hoopa Indian Reservation land, and one composed of a mix of federal, private, and state lands initiated in 1992 (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~~Dugger et al. In press; Figure ~~7~~1).

Periodically, the principal investigators, field biologists and a team of renowned analyst gather to individually and collectively analyze their data in what is termed the Northern Spotted Owl meta-analysis (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011, Dugger et al. In press). The~~se~~ eleven study areas included in the most recent meta-analysis ~~have~~ had been monitored annually since inception with an average of ~~19~~ 24 survey years across all areas (Table ~~6~~2) following the 2013 field season on which the Dugger et al (In press) publication was based. 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 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.

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

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).

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

Study Area	**Acronym**	**Years**	**Area (km^2)**	**Ownership**
Washington				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
Oregon				
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
California				
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 include data through 2013 (Dugger et al. *In press*). 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~~ are 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.

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.

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 lambda (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).

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

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.

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]
Washington				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
Oregon				
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
California				
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~~ing~~; 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 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 ~~A~~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).

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

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.

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~~a sixth meta-analysis ~~is ongoing~~has been completed and ~~will~~ includes ~~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) 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.

While the decline in reproduction coincided with the first major increase in Barred Owls in many areas of coastal California, ~~T~~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 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, Diller et al. 2010), 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 [LVD59]: 61.Replace with results from Dugger et al. In press.

Occupancy

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.

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 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 historical 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 Owls are~~is~~ present. The ~~ongoing~~ most recent 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 r~~Results ~~show~~ indicate that occupancy rates have declined at all three California study areas, with 32-37% declines from 1995-2013 (Dugger et al. in ~~review~~press). 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~~press). 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~~press). 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~~press).

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.

Outside of the three California demographic study areas, studies that have ~~compiled robust datasets suitable for evaluation of~~provided statistically rigorous estimates 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. 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 statistically 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~~a low of 82~~0~~ 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).

In contrast to the above studies at demographic study areas and at other well-monitored areas that showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the 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~~influenced by 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.

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

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~~In press). 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 ~~biased~~ skewed sample of all potential owl sites. The sampling scheme therefore results in biased estimates of occupancy for ~~the~~ all potential owls sites throughout 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.

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 is 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?

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.

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.

Source-Sink Dynamics

Pulliam (1988) was the ~~landmark~~ seminal publication on source-sink population dynamics. Since then, 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 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~~ simulated potential Northern Spotted Owl movement dynamics between modeling regions and physiographic provinces noted in the USFWS Revised Northern Spotted Owl Recovery Plan (USFWS 2011~~a~~). 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).

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.

Table 9. Model output of ~~S~~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
Modeling Regions			
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
Physiographic Provinces			
California Coast Range	16.6	Sink	100
California Cascades	2.8	Sink	35.9
California Klamath	36.4	Source	100

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.

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~~d~~ 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

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

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

Comment [LVD71]: 73.I recommend deleting this table and just providing the highpoints in the text.

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
	Modeling Regions		
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
	Physiographic Provinces		
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

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

Existing Management

Land Ownership Patterns in Northern Spotted Owl Range

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

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 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)
Total	*24,465,790 (100)*

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. However, silviculture treatments (including thinning in stands less than 80 years old west of the Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district plans as being withdrawn from timber production and include recreational and visual areas, back country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with smaller amounts of reserved lands on the coast (Figure 11).

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

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.

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

<u>Late Successional Reserves:</u>

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

- 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.

<u>Managed Late Successional Areas:</u>
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.

<u>Congressionally Reserved Lands:</u>
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).

<u>Administratively Withdrawn Areas:</u>
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.

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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:

- 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
- Retention of large snags and down logs within thinning units
- Retention of hardwoods
- 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.

<u>Headwaters Forest Reserve</u>

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

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

National Park Service

Redwood National and State Parks

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

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

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

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

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

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

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

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

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

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

<u>Point Reyes National Seashore and Muir Woods National Monument</u>

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

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

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

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

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

- Treatment activities or any noise generation above ambient noise levels will not occur within 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as surveys conforming to accepted protocol have determined that the site is unoccupied or non-nesting or nest failure is confirmed.

- Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially alter the percent cover of canopy overstory and will preserve multilayered structure. When shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency vehicle clearance.
- Prior to fire management activities, project areas will be surveyed for the presence of dusky footed woodrat nests. If feasible, woodrat nests will be protected.
- Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a determination is made that the native tree presents a clear hazard in the event of a fire or cutting is the only option to reduce high fuel loading.
- The fire management officer will arrange for qualified biologists to conduct post-project monitoring to determine short- and long-term effects of fire management actions on activity centers if resources are available.

Tribal Lands

Hoopa Valley Indian Reservation

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

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

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

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

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

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

Yurok Indian Reservation

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

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

The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for intensive surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites. The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on disturbance activities within 0.25 mile of Northern Spotted Owl nest.

Round Valley Indian Reservation

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

Nonfederal Land

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

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

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

A Timber Harvesting Plan (THP) is generally the environmental review document submitted by landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment. THPs are prepared by Registered Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These biologists would become the first "designated biologists" who would consult on proposed THPs. Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules and procedures that would be adopted in the event of listing. The rules identified descriptions of Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for timber operations to avoid take. The rules called for consultations between plan proponents and Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to amend the initially adopted emergency rules; amendments to the rules occurred several times as knowledge of the Northern Spotted Owl increased and with experience gained through implementation of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] in March 1991, 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.

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

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

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

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

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

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

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

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

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

Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol, breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol was revised (USFWS 2012).

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

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

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

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

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

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

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

- The Department felt CAL FIRE and USFWS staff were capable of review, approval, and assessment of THPs and NTMPs.
- The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- The scope, quality and conformance of owl-related information with Forest Practice Rules requirements appeared to have stabilized after approximately six years of implementation.

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

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

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

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

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

13 THPs from Interior Counties	Acres	62 THPs from Coastal Counties	Acres
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 habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat from Forest Practice Rules guidelines.

Forest Practice Rules guidelines under Option (g) are:

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

The USFWS (2009) recommendations are:

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

As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option (e) 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 six interior THPs, four primary habitat types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-habitat.

Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior, and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within 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; 47,344 acres of nesting and roosting).

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).

	6 Interior THPs associated with 14 activity centers, Option (e)		60 Coastal THPs associated with 132 activity centers, Option (e)
	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).

	7 Interior THPs associated with 8 activity centers, Option (g)		2 Coastal THPs associated with 6 activity centers, Option (g)
	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

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

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.

		Interior, Option (e) Acres harvested		Interior, Option (g) Acres harvested	
Activity Center	**Range of Harvest Years**	**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

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

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

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

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

Comment [A78]: 80.<u>Note to external reviewers</u>:
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.

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

Table 17. Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years 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
Interior Counties 1991-2014					
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
Coastal Counties 2005-2014					
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**

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

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**
Interior Counties 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
Coastal Counties 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**

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

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

The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear that some information was not available to the reviewer due to the nature of the older NTMP narratives, limited public information, and subsequent amendment submissions. There is simply no effective way to track this information in an analysis going back in time. Though Selection and Group Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range, we can infer that owl habitat is retained to some extent; however, we could not 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.

Spotted Owl Management Plans

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

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

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

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

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

Spotted Owl Resource Plans

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

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

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

Habitat Conservation Plans

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

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.

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/mi^2 and 0.32 owls/mi^2, 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

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

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

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

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

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

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

~~According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the understanding of suitable owl habitat was limited.~~ In 2006, GDRC submitted an application to the USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes the Project, requires the Applicant to comply with terms of the amended BO and its associated incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified the Department that the BO was issued and requested that the Department issue a consistency determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1. In January 2014, the Department found that BO, 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-Iisted species (CDFW 2014a).

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

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

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.

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).

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.

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.

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

Northern Spotted Owl management objective outlined in the plan include:

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.

Northern Spotted Owl conservation measures outlined in the plan include:

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.

2. Conduct a complete annual censuses (or an~~d~~ approved sampling methodology) to monitor all activity centers on the ownership and to determine numbers of pairs, nesting pairs, and reproductive rates.

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 31site 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.

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. Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable owl habitat must be provided, if present, and less than 50 percent of this shall be under operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided, within 1.3 miles of each activity center.

5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of each year to make up the minimum number of activity centers designated by the HCP. “Level Two” habitat retention must 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. Following the breeding season, 18 acres around the AC shall be maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC must the in place. For sites, which have been determined to be occupied by a non-nesting pair or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and a 400 foot radius buffer protecting the activity center must the in place. Harvesting of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat retention area.

6. Activity center that are not needed to meet management objectives above shall receive “Level Three” protection measures. These activity centers shall have a 1,000-foot buffer during the breeding season. Timber harvest associated may occur before March 1 or after August 31. During the breeding season, for activity centers which have been determined to be occupied by a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur during the breeding season in the area adjoining the 18-acre habitat retention area.

7. All nest trees shall be marked and be retained if the activity center is harvested.

The HCP outlines an objective to conserve habitat diversity and structural components within the plan area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types and seral stages are maintained across the landscape over the permit period, as well as structural components, to contribute to the maintenance of wildlife species covered under the plan, including the Northern Spotted Owl.

Structural components to be retained include:

1. A certain number and size snags that do not pose a human safety hazard.
2. A certain number and size of green replacement trees, if snags are not present, with a priority for trees other than redwood.
3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or cavities.
4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a maximum of two per acre.
5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given to logs over 30 inches in diameter.

In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in fact 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 2014b).

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

- Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and federal governments to ensure their functions as wildlife reserves in perpetuity.
- Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting habitat in a series of Marbled Murrelet Conservation Areas (MMCAs).
- Conduct a combination of night and daytime surveys and stand searches to locate both known, and any new, owl activity centers.
- Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other conservation elements of the HCP for the retention and recruitment of potential foraging, roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
- Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 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.
- Conduct complete annual censuses to monitor all activity centers on the ownership and to determine numbers of pairs, nesting pairs, and reproductive rates.
- Survey the THP area and a 1,000-foot buffer for new operations, except site preparation, initiated in the period beginning February 21 and ending on or before August 31.
- Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and detection probabilities using accumulated survey data.

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

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

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

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

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

Terra Springs LLC HCP

The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa County west of the city of St. Helena, and is located within the California Coast Province. The plan has a 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting, roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees, felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices, retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous 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 federal and private lands have shown that many activity centers are located on or have a home range that extends onto the FGS ownership.

<u>Safe Harbor Agreements</u>

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

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

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

Forster-Gill, Inc., Safe Harbor Agreement

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

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

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

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

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:

Comment [LVD87]: 90.Same comment as earlier

- 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.

<u>Exemption Harvest</u>

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

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

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

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

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

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

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

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

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

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

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

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

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

The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet from any point of an habitable structure that complies with California Building Code for the purpose of reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2, 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project area shall be increased in the post-harvest stand.

During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS, approximately 41,767,250 acres (1992 to 2013) have been included in a tally of lands exempted for harvest in counties within the 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 any or only a small area, thereby obviously ~~possibly~~ compounding this acreage total since the approximately 41.8 million represents over five times the total acreage of forested lands in private ownership within the range of the Northern 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.

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 MBF = 1,000 board-feet~~oot~~) 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~~ affecting 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.

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

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.
- Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood, landslide, or earthquake.
- Dead or dying trees as a result of air or water pollution.
- Cutting or removing trees required for emergency construction or repair of roads.
- Cutting and removal of hazardous fuels.
- Treatments to eradicate an infestation of Sudden Oak Death.

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

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

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

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

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

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.

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. Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak woodlands and prairies is managed through tree removal and burning. Nine management zones within the RNSP delineate the degree of human influence and development on that can occur on the landscape (NPS 2000a).

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

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

University of California Natural Reserves

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

Department Ecological Reserves

Authorized by the California Legislature in 1968 and administered by the Department, the ecological reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats, and to provide areas for education and scientific research. The system now encompasses 119 properties totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur within the range of the Northern Spotted Owl; however there are no management plans for the system or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by BLM, which manages for late seral habitat benefiting Spotted Owls.

Fisheries Restoration Grant Program

As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern Spotted Owls and their habitat are required for each project funded. The purpose of FGRP is to support restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must 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 and Regrowth

Historical (pre-logging) variability in forest age and structure in the range of the Northern Spotted Owl was ~~controlled by~~a function of 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). However, Wimberley et al. (2000) estimated that old growth forests covered between 25 and 75% of the Oregon Coast Range province over a 3,000 year simulation. At the scale of late successional reserves (40,000 ha) old growth, they estimated percentages varied from 0 to 100%. 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 2011~~a~~). 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 2011~~a~~). This pattern of historical loss is apparent in the current distribution of suitable habitat, with large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat (see Figure 4).

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

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

Assessing Habitat Loss through Implementation of the Northwest Forest Plan

The Northern Spotted Owl was listed under the federal Endangered Species Act in 1990 in part because of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls, 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.

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

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

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

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

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

Comment [LVD94]: 98.Same timeframe uncertainty.

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

Comment [LVD95]: 99.Same issue continues

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

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

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.

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 2011~~a~~).

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 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. However, this same form of timber harvesting in the redwood region has been documented to create the greatest abundance of dusky-footed woodrats in even-aged stands 5-20 years post-harvest while thinnings did not create habitat for this key prey species of the spotted owl (Hamm and Diller 2009). Impacts from harvest have been recognized in the literature since the time the owl was federally listed (UFWS 2011~~a~~). 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~~monitoring of Spotted Owl responses to ~~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 the regrowth potential of owl habitat including important prey species habitat.

To evaluate the ~~level of impact of~~changes that proposed harvest and retention have on ~~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 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 utilizing 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

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.

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 the level of information available, particularly older plans, was limited in some cases. Considering 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, Diller et al. 2010) – 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 some level of timber harvesting may be beneficial, but too 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 in the north interior region to USFS lands from 1978-2007 the USFWS (2009) found ~~a~~ 54% ~~decline~~ ~~in~~of sites with pairs ~~status to no response~~became unoccupied and ~~a~~ 23% ~~decline from~~of the sites with pair status ~~to~~became occupied by single owl~~s 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 for the north interior region. In contrast, in the coastal redwood region, a certain level of even-aged timber harvest in which late seral habitat elements are retained has been shown to be a critical element in maintaining habitat heterogeneity in the absence of natural disturbance events such as stand replacing wildfire that historically was responsible for creating habitat heterogeneity (Diller et la. 2010).

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 thinnings 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, thinnings 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?

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

As discussed in the Habitat Requirements section of this report, 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; Franklin et al. 2000). See the Habitat Effects on Survival and Reproduction section of this report for a discussion of HFP and additional studies that have contributed to an understanding of habitat characteristics that provide high HFP. The studies that have evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

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

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

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

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.

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

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.

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, Diller et al. 2010) 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 detection ~~response~~ and occupancy rates have 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 Livezy 2003, Gremel 2005, Olson et al. 2005, Crozier et al. 2006 Kroll et al. 2010, Dugger *et al*. 2009, Dugger et al. 2011, Wiens *et al*. 2011)~~ have declined are unknown~~, there are multiple likely factors 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 protecting loss of Northern Spotted Owl habitat within its range in California.

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.

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	Retain sufficient functional characteristics to support roosting and provide protection from predation and

	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).

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			

[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.

Table 22. 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 interior region of California (USFWS 2008b and 2009).

<table>
<tr><th>Habitat Type</th><th>Within 1,000 feet of Activity Center</th><th>Acre Retention in Core Area (within 0.5 mile; ~500 acres) [1]</th><th>Acre Retention in Outer Ring (between 0.5-1.3 mile; ~2,900 acres) [1]</th><th>Acre Retention in Home Range (total up to 1.3 mile; ~3,400 acres)</th><th>Basal Area Parameter</th><th>Quadratic Mean Diameter Parameter</th><th>Large trees/acre Parameter</th><th>Canopy Closure Parameter</th></tr>
<tr><td>High Quality Nesting/Roosting</td><td rowspan="4">No timber operations are allowed other than use of existing roads.</td><td>100 acres</td><td>NA</td><td>100 acres</td><td>≥ 210 ft^2/acre</td><td>≥ 15 inch</td><td>≥ 8</td><td>≥ 60%</td></tr>
<tr><td>Nesting/Roosting</td><td>150 acres</td><td>NA</td><td>150 acres</td><td>Mix, ranging from 150 to ≥ 180 ft^2/acre</td><td>≥ 15 inch</td><td>≥ 8</td><td>≥ 60%</td></tr>
<tr><td>Foraging</td><td>100 acres</td><td>655 acres</td><td>755 acres</td><td>Mix, ranging from 120 to ≥ 180 ft^2/acre</td><td>≥ 13 inch</td><td>≥ 5</td><td>≥ 40%</td></tr>
<tr><td>Low-quality Foraging</td><td>50 acres</td><td>280 acres</td><td>330 acres</td><td>Mix, ranging from 80 to ≥ 120 ft^2/acre</td><td>≥ 11 inch</td><td>NA</td><td>≥ 40%</td></tr>
</table>

[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.

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.

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.

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 form 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

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

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 mi^2) 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

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 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, 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; much uncertainty remains on the effect of wildfires on the extent and quality of Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates by Spotted Owls have 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 and from southwestern Oregon in the range of the Northern Spotted Owl, 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

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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 ≥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).

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

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

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

<u>Historical Fire Regime in the Klamath Province</u>

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 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.

<u>Historical Fire Regime in the Cascades Province</u>

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 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 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).

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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 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).

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

Several studies have determined a strong link between changes in fire extent, severity and season, with low precipitation and high temperatures. In addition to land-use history over the last century, climate 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.

<u>Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat</u>

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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 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).

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 2011~~a~~).

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).

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 that 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. McIntrye 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. 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 120,000km^2 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.

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.

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 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 with low elevation forests predominately composes of ~~and tend to be~~ redwoods ~~species dominant~~ and of a younger age class, whereas inland regions are drier and warmer and tend be mixed conifer/hardwood or Douglas-fir dominant.

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?

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.

Studies have indicated that Northern Spotted Owl demographic rates are~~survival is thought~~ linked to ~~precipitation~~ weather 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 (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 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must include structurally complexity to provide nesting options with proper protection. The intensity of disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may increase the level of structural complexity.

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

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

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

Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-August) and winter months (December-February) separately. Comparing the 30-year average with the 5-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 sever 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. It will require ~~M~~more time and 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.

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.

Barred Owl

Barred Owl Expansion and Current Status in California

Section needs to start with a brief description of the barred owl relative to spotted owls. 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, ~~Barrowclaugh~~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.

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.

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 2011~~a~~, 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 1,970[3] 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 hybrid~~s~~ pairs observed in the field or 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

[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.

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 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). In a coastal Oregon study, Wiens et al. (2014) showed that Barred Owls showed strong selection of old forests for both daytime roosting and nighttime foraging. Furthermore, the pattern of Barred Owl colonization in coastal northern California indicated that Barred Owls completely occupied the old growth forests of Redwood National and State Parks (see Occupancy section above, Schmidt 2013) while occurring in relatively low numbers on the adjacent managed timberlands of the Green Diamond study area (Diller et al. 2014, GDRCO 2015) 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 used available forest types more evenly than spotted 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).

Home range analyses show the importance of mature forests for nesting by both Barred and Spotted Owls; however, one study in Washington indicated that Barred Owls select other forest cover types similar to their availability whereas Spotted Owls ~~are~~ were 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~~ one area~~s~~ of sympatry, little overlap exist~~s~~ed between Barred and Spotted Owl home ranges, which ~~i~~was 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.

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.

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.

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 [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.

territories where barred owls were detected within 0.8 km of the territory center. Pearson and Livezey (2003), Gremel (2005) and Sovern et al. (2014) also reported relationships between barred owl presence and reduced site occupancy by spotted owls. In Olympic National Park, an area with historical 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).

Spotted Owls will reduce their calls or not call at all if Barred Owls are in the vicinity (Cozier et al. 2006, , Sovern at 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).

Data ~~is~~ are lacking to adequately assess Barred Owl abundance in western North America. However, based on the most recent meta-analysis, Northern Spotted Owl populations are declining throughout most of their range (Dugger et al. In press). ~~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~~Dugger et al. In press). 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).

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

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

~~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.~~

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

~~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 a. 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~~By 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 [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

~~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). When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed (Diller 2012).~~
~~During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97% adutls, 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.~~

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

~~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 at 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).~~

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

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 individual females tend to breed every year compared to Spotted Owls that typically breed every other year ~~and Barred Owls may produce up to three clutches per season, both of~~ all of which ~~may~~ leads to higher productivity (Gutiérrezet al. 1995, Mazur et al. 2000, Gutiérrezet al. 2007, Wiens et al. 2014, Dugger et al. In press). Wiens et al. (2014) documented that pairs of Barred Owls produced an average of 4.4 times more young than pairs of Spotted Owls over a 3-year period in coastal Oregon. ~~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).~~

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 renest up to 3 times following a nest failure, but there is no way they could even produce 2 clutches in a single season.

~~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).~~

Comment [LVD132]: 136.Moved to below

Comment [LVD133]: 137.Already covered

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

Owls likely will be dominant in interspecific aggressive exchanges. Anecdotal observations of aggressive physical interactions between the two species have indicated that Barred Owls tend to dominate due to their larger size (Carlson 2015, Diller pers. comm.). ~~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.~~ Most Spotted Owl biologists do not believe that these physical encounters frequently result in serious injury to Spotted Owls, but 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 occasionally 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).

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.

This interspecific competition over territories indicates 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, Wiens et al. 2014). In possibly the best designed and implemented study of Barred Owl and Spotted Owl interactions to date, Wiens et al. (2014) concluded that Barred Owls were limiting the availability of old forests and associated prey species for Spotted Owls and this was the most strongly limiting factors in the competitive relationship between these species. In other words, the greatest impact of Barred Owls is to effectively act as a form of functional habitat loss for Spotted Owls.

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 detection rates, survival, fecundity and occupancy, but most importantly, displacement from and making unavailable essential habitat for roosting, nesting and possibly foraging~~,~~ ~~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.

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

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).

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.)

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% adutls, 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).

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.

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 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.

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 Hippoboscid flies on 62 of the 382 Northern Spotted Owls captured over five years between April and September, with higher prevalence in adults that 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 Hippoboscid 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, 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 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 bromadiolone) 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 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

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.

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.

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.

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytopthora 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. *Phytopthora 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.

Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases quickly. Cobb et al. (2009) examined mortality caused by sudden oak death within coastal redwood forests from Sonoma to Monterey counties. 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. 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. The study found that live oak and tanoak survival declined as a function of disease state. Coast live oak survival was 11.7 to 15.8 years for asymptomatic trees; 7.5 to 11.7 years for trees 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).

After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi and insects is common and impacts survival times. 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. 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 (m^2/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).

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 course 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 (Tempel 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 course 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 (2011~~a~~) 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,

> "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).

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.

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 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance with the presence of hikers (Swarthout and Steidl 2003).

It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the level to which these activities may impact owl behavior, reproduction and overall survival 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

There had previously 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 provides compelling evidence that a population bottleneck may have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from 352 Northern Spotted Owls from six regions across the range which included limited samples from the northern portion of the California Klamath Province.

> Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades) bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic variation and hence effective population size, do not necessarily indicate a decline in actual (demographic) population size (Funk et al. 2010) "… it is important to keep in mind that reductions in [effective population size] (detected with bottleneck tests) are different than reductions in demographic population size (detected with demographic field studies) and reductions in one of these parameters does not necessarily result in a change in the other." (Funk et al. 2010)

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). Geneticists ~~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 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.

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.

<u>California Forest Practice Rules</u>

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 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the broader home range (1.3 mile radius).

The most recent research on Northern Spotted Owl habitat requirements in California and southern Oregon have demonstrated a link between owl fitness and the amount of types of habitat, structural characteristics, and spatial configuration in a home range. This requirement for habitat heterogeneity is consistent with the general approach incorporated in the Forest Practice Rules. Although study design has varied across the major research studies, some consistent patterns have arisen. In order to support productive Spotted Owl territories, a minimum amount of older forest must be retained in the core area. The definition of 'older forest' evaluated in studies has varied, but consistently includes late-seral forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older forest in an approximately 400 acre core area.

Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness. Results indicate that in order to support a productive Northern Spotted Owl territory, no more than about 50% of a home range should consist of nonhabitat.

The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls in the northern interior region. The total acreage of recommended retention in the USFWS guidance does not differ from that found in the Forest Practice Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range must be retained in habitat. However, based on assessment of core use areas in the interior portion of the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations in line with core use areas evaluated in recent work. The most significant change in the revised USFWS recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained near the core is consistent with the literature.

A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised USFWS recommendations (see Table 22 for the interior portion of range in California) shows large discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres). This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500 acres 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 under Forest Practice Rules, a definition that is considered low quality foraging habitat by the USFWS; therefore there is no requirement in the Forest Practice Rules for this habitat include nesting or roosting habitat under the Forest Practice Rules.

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Our assessment of selected activity centers shows that the habitat retention guidance in the Forest Practice Rules are not always met, indicating that harvest is impacting Northern Spotted Owl at some locations. Of the activity centers evaluated, several experienced very high acreages of harvest at both the broad home range and in the core area, which would have resulted in territories that do not meet the USFWS recommendation for take avoidance, and would have resulted in declines in survival and fitness of the local owls.

Documentation of habitat type, amount, and distribution present around activity centers after THPs are implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if minimum retention requirements in the Forest Practice Rules are implemented as written, there is still the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts that have occurred in recent years.

The THP review and post-harvest follow-up process should ensure that the best scientific information is being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a sample of activity centers indicates that it is not universally applied and that insufficient habitat has been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

Comment [LVD143]: 147.I have no doubt that habitat is being lost at some NSO sites, but it 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 it 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.

<u>Salvage Logging</u>

Several variables complicate the interpretation of owl response to fire, including variation in fire severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing and duration of research post-fire. Regardless, several studies 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. Although hampered by small sample size, incidental observations have documented declines in occupancy of burned areas following salvage logging. Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction probabilities, although the impacts of salvage logging were observed only in combination with other factors.

The presence of snags has been suggested as an important component of prey habitat and as perch sites for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub and herbaceous cover and number of snags, may be impacted by salvage logging.

Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the fire itself, by removing important structural elements and removing important prey habitat. The available information suggests that salvage logging reduces the probability that spotted owls will use burned areas and has resulted in declines in occupancy, either through abandonment or declines in survival.

Wildfire

Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994, after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to 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.

The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to use burned areas extensively, although nesting and roosting general occurred only in unburned or low-severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

Conversely, Northern Spotted Owls in southern Oregon were shown to have declines in occupancy following fire. These declines resulted from both high extinction rates in burned areas and low colonization rates.

Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to experience declines in survival. Food limitation in burned areas may have been a factor in declining survival rates. These observed declines in southern Oregon may be confounded by the occurrence of post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in the year following fire; these owls were not tracked to investigate potential longer-term effects.

Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance for foraging.

The available information suggests that wildfires can have positive effects on Northern Spotted Owls when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without removing important nesting and roosting habitat components at the territory scale. However, uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be used as a management tool.

Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades, fires have become more frequent and average fire size has increased. In some cases fires have also burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry and hot conditions). Because climate change will likely increase the likelihood of conditions that support fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

Climate Change Impacts to Forest Composition and Structure

Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate projection scenarios specific to California, the most notable response to increase temperature was a shift from conifer-dominated forests (eg., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g., Douglas fir-tan oak) in the northern half of the state), expansion of conifer forests into the northeast portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-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.

Comment [LVD145]: 149.Not according to Steve Sillett's research

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.

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.

Other Mechanisms of Habitat Loss

<u>Sudden Oak Death</u>

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.

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.

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 is 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 slow process given tree species growth rate (with a possible exception on the coastal redwood forests), and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

One 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 survival, to model source-sink dynamics across the range of the owl. In addition to an evaluation of source-sink dynamics, outcomes of the model included a range-wide prediction of the potential population size capable of being supported based on model parameters~~estimate~~, and the proportion of the population capable of being supported in each modeling region and physiographic province noted in the 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The study ~~estimated~~ projected 3,400 female Northern Spotted Owls could be supported range-wide, with over 750 females in the Inner California Coast, Klamath East, Klamath West, Redwood Coast, and West Cascades South modeling regions. Three provinces located in California were ~~estimated to contain~~projected to be capable of supporting over 50 percent of the range-wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a potential stronghold for the population. Even though the complexity of the model may limit its ability to accurately model population ~~estimates~~projections, 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.

Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for more than two decades to assess demographic parameters such as population growth, survival, fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study areas range-wide. In California, the most recent meta-analysis covering years 1985-~~2008~~ 2013 reported a 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation study area reported a 2.3% population decline per year through 2012. When converting estimates for population change 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) two study areas in California (Green Diamond Resource Company and Northwest California) showed estimated population declines of about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The ongoing analysis has revealed declines in California between 32 and 55% over the study period.

In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in

Comment [LVD148]: 152.I think it is inappropriate to refer to a modeling exercise as a "study" which implies data were collected on owls.

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).

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Washington and Oregon. Although less severe than in Washington and much of Oregon, all three California study areas show declines in survival.

Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in California give us information on current estimates for reproductive success (number of young fledged per monitored site) and survival, and are consistent with a continued decline within all demographic study areas in California. 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 despite weather conditions that would typically support good reproductive success. This was observed on many timber company lands, tribal lands, and National Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive rate since 2009.

The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study areas in California reflected trends on non-federal lands because two study areas are on non-federal lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal land. However, the authors also suggest that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands because the non-federal lands included in the demographic study areas are managed for owls. Results from the demographic study areas are thought to be 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 large, distributed across a broad geographic region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

Occupancy data is based on the presence or absence of owls from known sites. 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. Although an evaluation of occupancy rates has not been included in previous demographic meta-analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have declined at all three California study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on occupancy by increasing the local territory extinction rate.

Occupancy has been shown to be in decline for areas outside the California demographic study areas as well. For example, the southern Cascades and interior Klamath provinces of California determined occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

It is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of demographic rates across the range indicate the declines in demographic parameters, including population size, have accelerated. The level of decline does not seem to be slowing even with the implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at threats leading to these declines is warranted, including revaluation of the effectiveness or management techniques across the Northern Spotted Owl range in California.

Predation

Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted Owls is not a threat to the population. In the case of documented Barred Owl aggression toward Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities were due to territorial aggression. Given that predation is not considered to be a major threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly manage predation issues.

Competition

Over the last several decades, Barred Owls have gradually moved further into the range of the Northern Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been present the longest (British Columbia and Washington), with fewer detections made in the southern edge of the range (California) where they have been present for a shorter duration. Currently, Barred Owls have been documented in all portions of the Northern Spotted Owl range throughout California, though densities of Barred Owls are unknown.

Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong indication that the two species can coexist over time, sharing the same habitat and prey-base, because there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and not by Barred Owls.

~~Public workshops held by the USFWS have resulted in four published and one unpublished meta-analyses since 1994 to assess population parameters, such as abundance, trend, and survival.~~ 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 have been more prevalent where Barred Owls density was greatest. Northern Spotted Owl adult survival has declined in a majority of the range where Barred Owls were present, with a more gradual decline noted in California largely attributed to the relatively more recent Barred Owl expansion into this portion of the range. 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.

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 ~~E~~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 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and longer drier summers.

Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These studies indicate that winter precipitation is closely associated with a decrease in survival and recruitment; population growth was positively associated with wetter conditions during the growing season (May through October) and negatively associated with cold/wet winters and nesting seasons, and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction increased with late nesting season precipitation and decreased with warm temperatures; and owls may be more sensitive to changes in spring time climatic events.

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 sever 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 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where applicable. As new information becomes available, recommendations may be further refined.

Planning and Timber Practices

1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is consistent with the recovery of the species (see RA14).
2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-range planning, setting priorities for scientific research and investigations, and/or when making major decisions affecting the Northern Spotted Owl (see RA5).
3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative opportunities for nonfederal landowners to engage in management strategies (see RA15).
4. Consider long-term maintenance of local forest management infrastructure as a priority in planning and land management decisions (see RA16).
5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of Northern Spotted Owls (see RA21).
6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration, HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
7. Improve thorough documentation of harvest prescription methods within timber harvest plans and a rigorous ~~evaluation~~ quantification of post-harvest levels of foraging, nesting, and roosting

habitat and use those results in conjunction with field experiments to monitor the response of Spotted Owls to various levels of post-harvest habitat retention.

8. ~~Evaluate~~ Experimentally test the effects of silvicultural practices on important prey species (e.g., flying squirrel, woodrat) and their habitat.

Population Trend and Demographic Parameters

9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if the California population is decreasing, stationary or increasing (see RA2).
10. Develop ~~predictive modeling~~a methodology for estimating Northern Spotted Owl occupancy across its California range (see RA3).
11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival, population growth and reproductive rates of Northern Spotted Owls in California, and determine if negative impacts of climate change outweigh the positive ones.

Habitat

12. Manage Northern Spotted Owl habitat in a way that accelerates the development of structural complexity and biological diversity that benefits Spotted Owl (see RA6)
13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl habitat) while allowing for other threats, such as wildfire and insects, to be addressed by restoration management actions (see RA32).
14. ~~Conserve~~ Manage Northern Spotted Owl sites and high value habitat including the need to maintain high habitat heterogeneity in some regions to provide additional demographic support to population dynamics (see RA10).
15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to inform decisions concerning the possible development of habitat conservation networks in California (see RA4).
16. Assess habitat requirements for, and barriers to, dispersal in California through research on Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and availability, and habitat modeling.
17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath Province) to assist evaluating landscape-level issues in the Provinces in California, including monitoring and adaptive management actions (see RA7 and RA9).

Wildfire

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.

19. 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.

20. Conduct experiments to better understand how vegetation management treatments (e.g., thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern Spotted Owl habitat, prey abundance and distribution, and demographic performance (see RA11).

    a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in use of burned areas for foraging warrants additional research on long-term use of burned areas post-fire.

21. Gather information 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.

22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.

23. Develop a process for evaluating the likely effects of post-fire management activities, such as salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate this process into post-fire management decisions.

24. Concentrate post-fire silvicultural activities on conserving and restoring habitat elements that take a long time to develop, such as large trees, medium and large snags, downed wood (see RA12).

Barred Owl

25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy, reproduction, ~~and~~ survival and population trends in California (see RA23).

26. Promote experimental removal of Barred Owls within Northern Spotted Owl range, and if lethal removal is deemed a long-term management tool to manage negative effects of Barred Owls, explore methods for implementation within California (see RA22, RA29, and RA30).

27. Investigate the potential for resource partitioning of Barred Owls and Northern Spotted Owls (see RA26).

28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted Owl interactions.

    a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by the presence or absence of Barred Owls, but other unknown factors may also play a 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.

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.

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 resource management agencies will allocate funds towards protection and recovery actions may increase.

Economic Considerations

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).

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.

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

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

Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7) prior to any timber operations on such lands, an area may be harvested provided it is restocked in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be included in the THP. The regeneration plan shall include site preparation, method of regeneration, and other information appropriate to evaluate the plan.

Fuelbreak/Defensible Space
Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a shaded fuel break or defensible space in an area to reduce the potential for wildfires and the damage they might cause.

Variable Retention
Section 913.4(d) - Variable retention is 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.

Conversion
Section 1100 – within non-timberland production zone (TPZ) timberland, transforming timberland to a nontimber growing use through timber operations.

Alternative Prescription
A written analysis of preharvest and postharvest timber stand conditions and a description of the silvicultural practices and systems to be used in lieu of the standard methods. 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.
Section 913.6 – When an Alternative method is used, the plan must include a statement of which silvicultural method in the current District rules is most nearly appropriate or feasible and an explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how the proposed alternative prescription will differ from the most nearly feasible method in terms of securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in terms of fire, insect and disease protection.

NonTimberland Area
Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land, other than land owned by the federal government and land designated by the board as experimental forest land, which is available for, and capable of, growing a crop of trees of a commercial species used to produce lumber and other forest products, including Christmas trees.

Road Right of Way
No strict definition

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

such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with characteristics of topographic relief and aspect which alter microclimates.

Functional Roosting Habitat during the territorial breeding season, consists of stands where average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers provide an average of at least 40% canopy closure but the stand can have a high degree of variability. Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for protection from various environmental conditions, including wind, heat, and precipitation.

Owl Habitat means Type A, B, or C owl habitat or those areas with functional foraging habitat, functional nesting habitat, and functional roosting habitat which support the owl's biological needs for breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls are known to occasionally inhabit less than optimal forest structure, local information can be used to justify the modification of functional habitat definitions.

Type A Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:
1. Canopy layers: The stand has two distinct tiers or is multi-layered with dominant conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.
2. Canopy Closure: The canopy closure of conifers greater than 120 ft. tall (or greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.
3. Large Trees: The density of conifers greater than 35 in. dbh averages more than nine stems per acre and not less than six stems per acre and includes a component of trees with sparse, broken, or dead tops.
4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre and not less than 8 stems per acre.
5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type B Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:
1. Canopy Layers: Moderately to strongly two-tiered or multi-layered with dominant conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.
2. Canopy Closure: The canopy closure of conifers greater than 100 ft. tall (or greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.
3. Large Trees: The density of conifers greater than 35 in. dbh averages more than six

stems per acre and not less than two stems per acre.

4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 25 stems per acre and not less than 20 stems per acre.

5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type C Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy Layers: Uniform to moderately layered with dominant conifers or hardwoods 50 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.

2. Canopy Closure: The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.

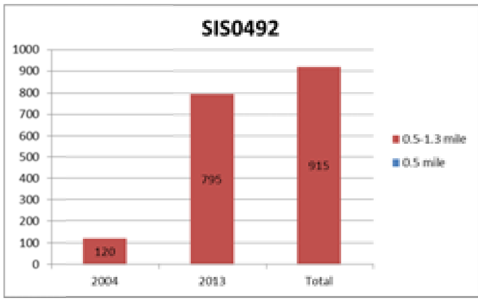
3. Large Trees: The density of conifers greater than 35 inches dbh averages less than six stems per acre and may be absent.

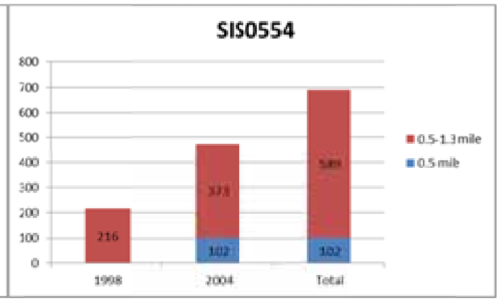
4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre, but may be absent.

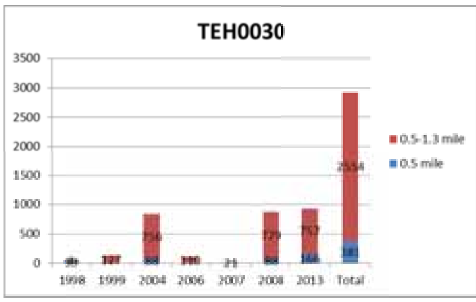
5. Small Trees: The density of conifers or hardwoods less than 18 inches dbh averages more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the stand, including small, medium, and large trees is greater than 10 inches.

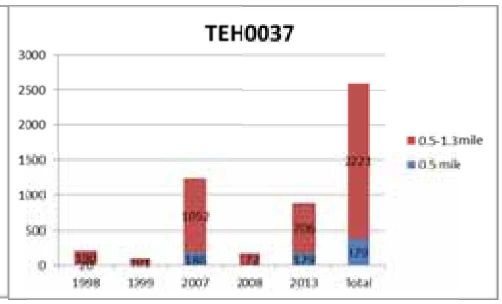
Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

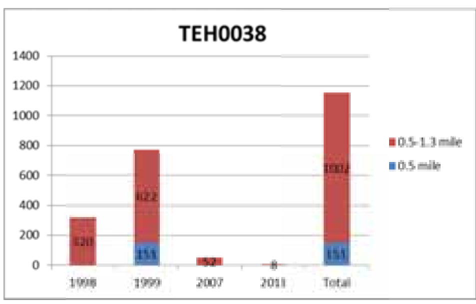
THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

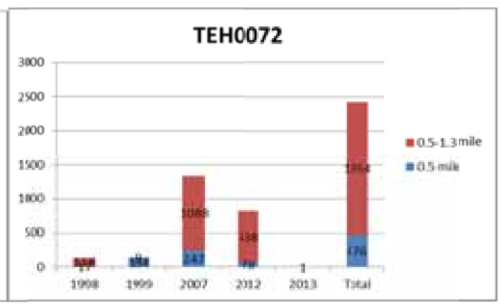












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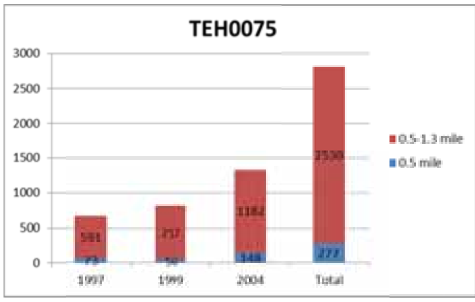

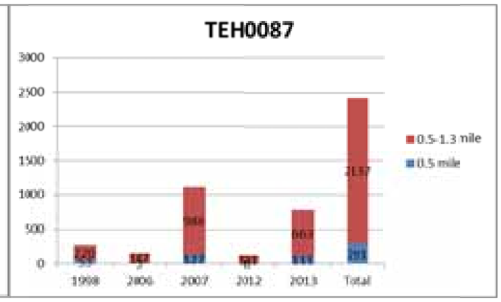

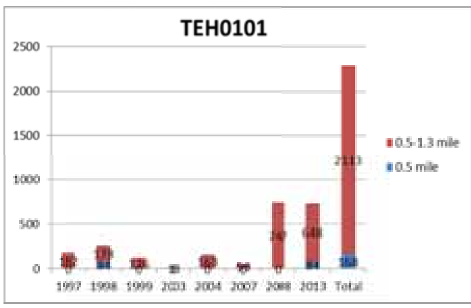

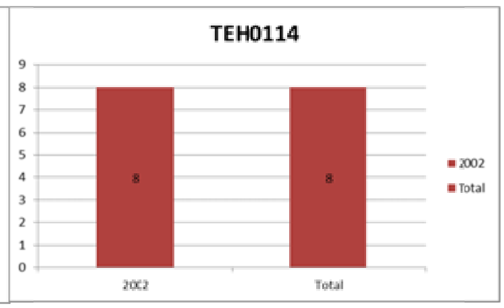

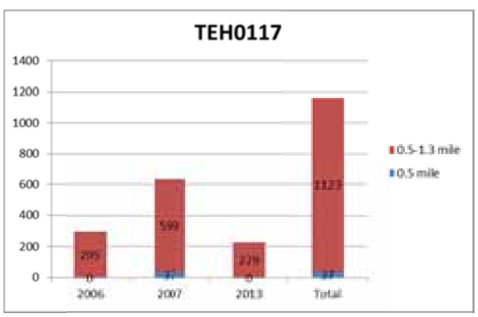

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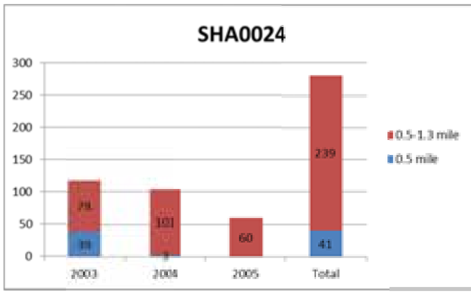
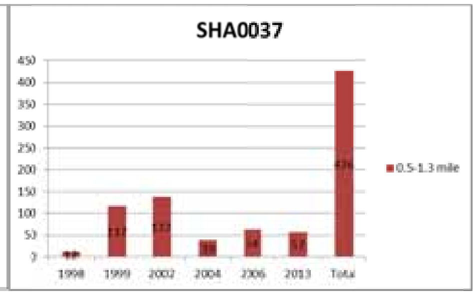
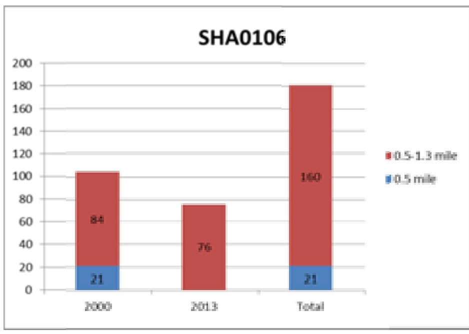
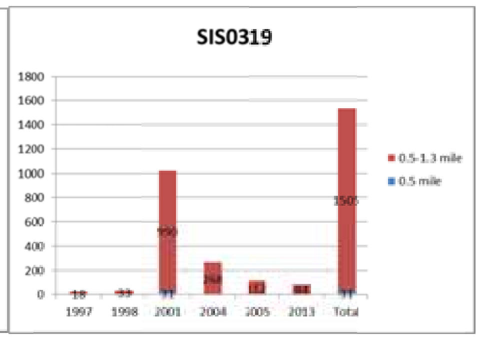
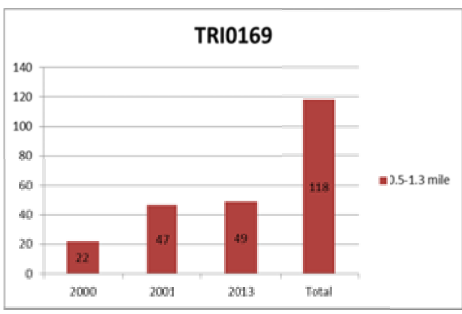
THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC

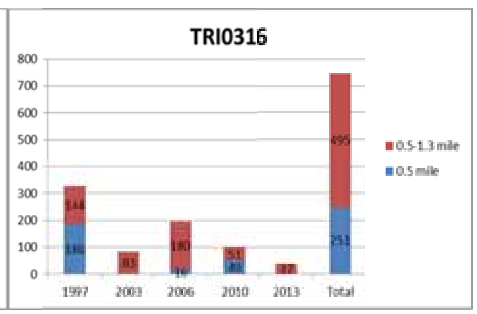












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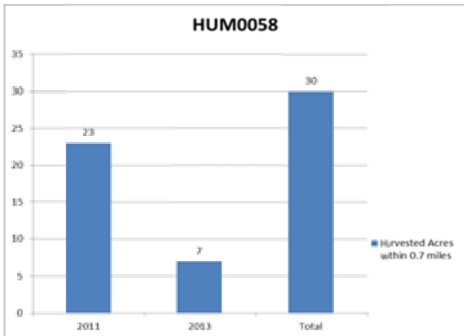
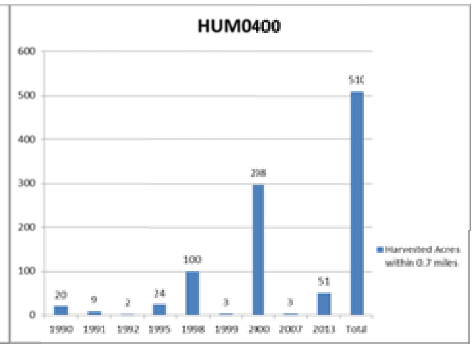
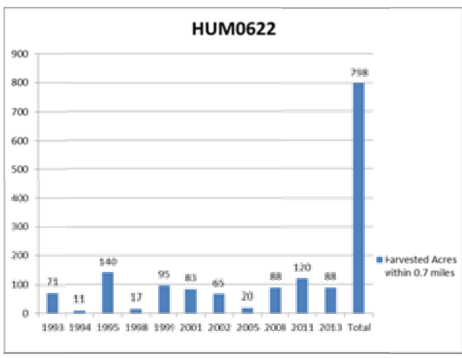
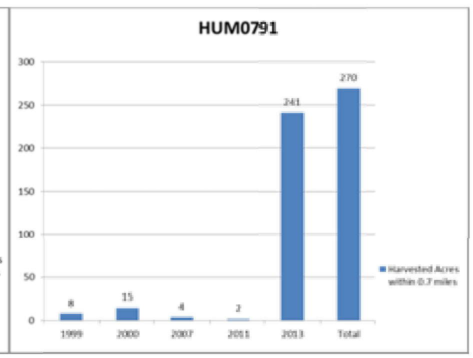
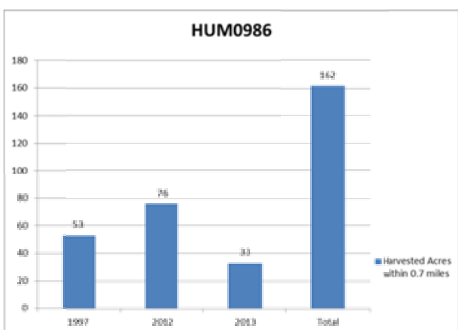
THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

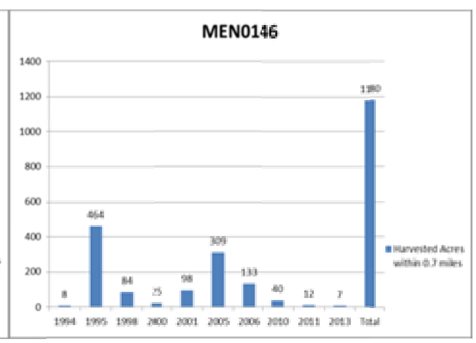












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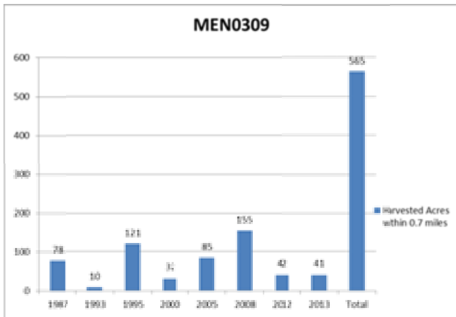

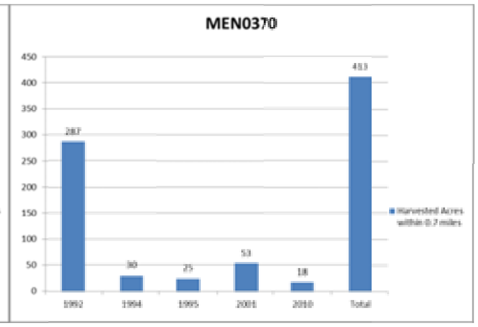

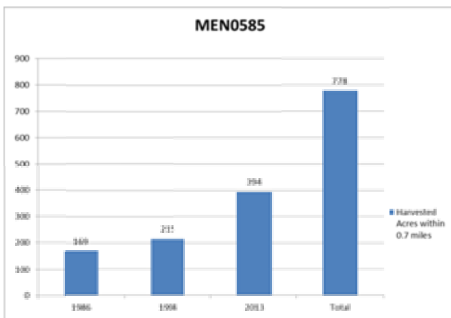

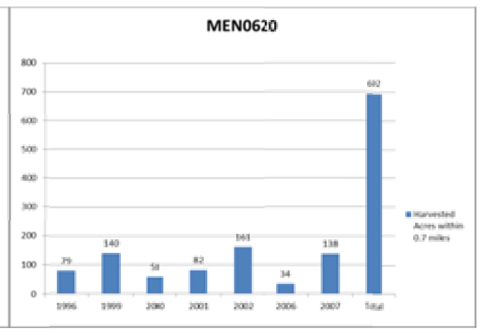

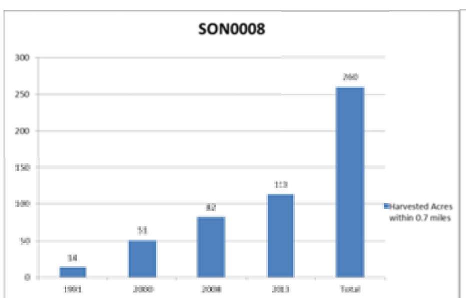

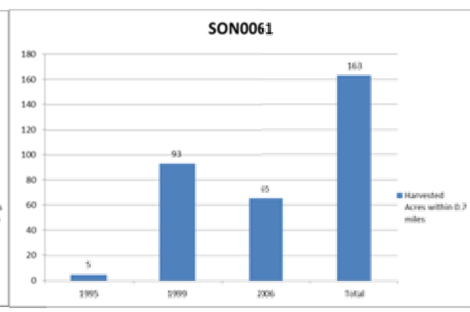

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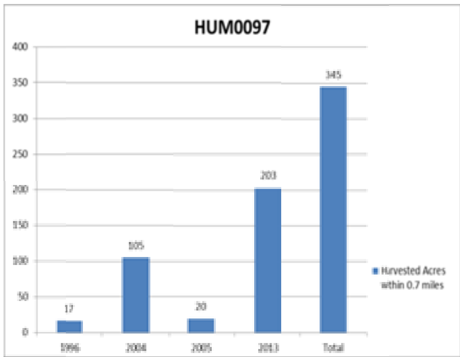
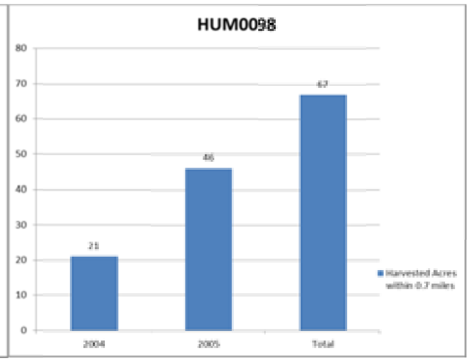
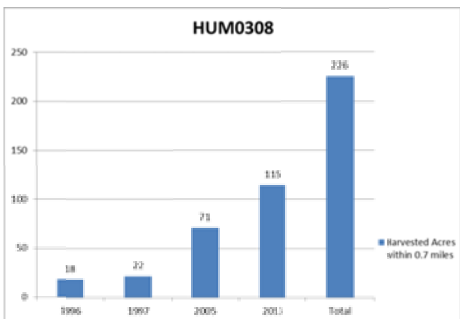
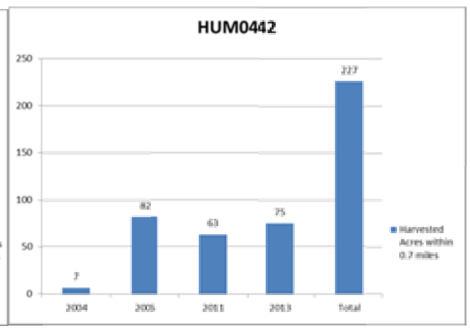
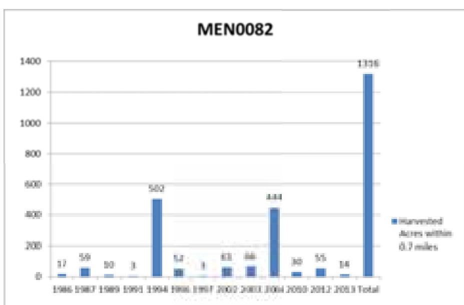
THP's utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

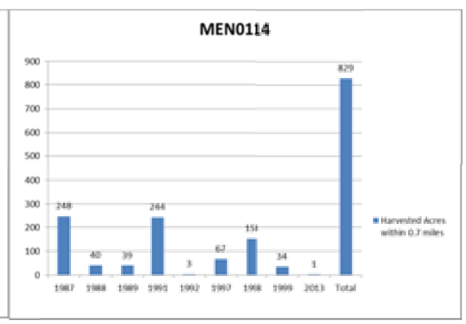












Appendix 4. List of Acronyms and Abbreviations

AC	Activity Center
AMA	Adaptive Management Areas
AR	Anticoagulant Rodenticides
BLM	Bureau of Land Management
Board	Board of Forestry and Fire Protection
BO	Biological Opinion
BOE	Board of Equalization
BOF	State Board of Forestry and Fire Protection
CA State Parks	California Department of Parks and Recreation
CAL FIRE	California Department of Forestry and Fire Protection
Caltrans	California Department of Transportation
CBD	Center for Biological Diversity
CD	Consistency Determination
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CCAA	Candidate Conservation Agreement with Assurances
CDFW	California Department of Fish and Wildlife
CI	Confidence Interval
CNDDB	California Natural Diversity Database
Commission	Fish and Game Commission
CPV	Canine Parvovirus
CSA	Conservation Support Areas
CWHR	California Wildlife Habitat Relationships
DBH	Diameter at Breast Height
DSA	Density Study Area
Department	California Department of Fish and Wildlife
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
ESA	Federal Endangered Species Act
FEIS	Final Environmental Impact Statement
FRGP	Fisheries Restoration Grant Program
FGS	Fruit Growers Supply Company
FEMAT	Forest Ecosystem Management Assessment Team
FIA	Forest Inventory Analysis
FMP	Forest Management Plan
FPA	Forest Practice Act
FRI	Fire Return Interval
FSC	Forest Stewardship Council
GDR	Green Diamond Resource Company study area
GDRC	Green Diamond Resource Company
ITP	Incidental Take Permit
ITS	Incidental Take Statement
JDSF	Jackson Demonstration State Forest
HCP	Habitat Conservation Plan
HFP	Habitat Fitness Potential

HCVF	High Conservation Value Forests
HUP	Hoopa Indian Reservation study area
HRC	Humboldt Redwood Company
LSA	Late-Successional Areas
LSAA	Lake or Streambed Alteration Agreement
LSR	Late-Successional Reserve
MBF	1,000 board-foot
MIS	Management Indicator Species
MMCA	Marbled Murrelet Conservation Areas
MRC	Mendocino Redwood Company
NCA	National Conservation Area
NCCP	Natural Community Conservation Plan
NIPF	Non-industrial private forest
NPS	National Park Service
NSO	Northern Spotted Owl
NTMP	Nonindustrial Timber Management Plans
NTO	Notice of Operations
NWC	Northwest California study area
NWFP	Northwest Forest Plan
ORV	Off Road Vehicle
PCB	Private Consulting Biologists
PFT	Pacific Forest Trust
PL	Pacific Lumber Company
PRNS	Point Reyes National Seashore
PSU	Primary Sampling Unit
REF	Suppressed reproduction and growth
RNSP	Redwood National and State Parks
ROD	Record of Decision
RPF	Registered Professional Foresters
SEIS	Supplemental Environmental Impact Statement
SHA	Safe Harbor Agreement
SOMP	Spotted Owl Management Plans
SOP	Spotted Owl Expert
SORP	Spotted Owl Resource Plan
SFI	Sustainable Forestry Initiative
SP	State Park
SPI	Sierra Pacific Industries
TCP	Timberland Conservation Planning Program
THP	Timber Harvest Plan
TPZ	Timber Production Zone
UCNRS	UC Natural Reserve System
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USFS	United States Forest Service
WCSA	Willow Creek Study Area
WLPZ	Watercourse and Lake Protection Zones

WNV	West Nile virus

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

FIGURES FROM REPORT ONLY

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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).
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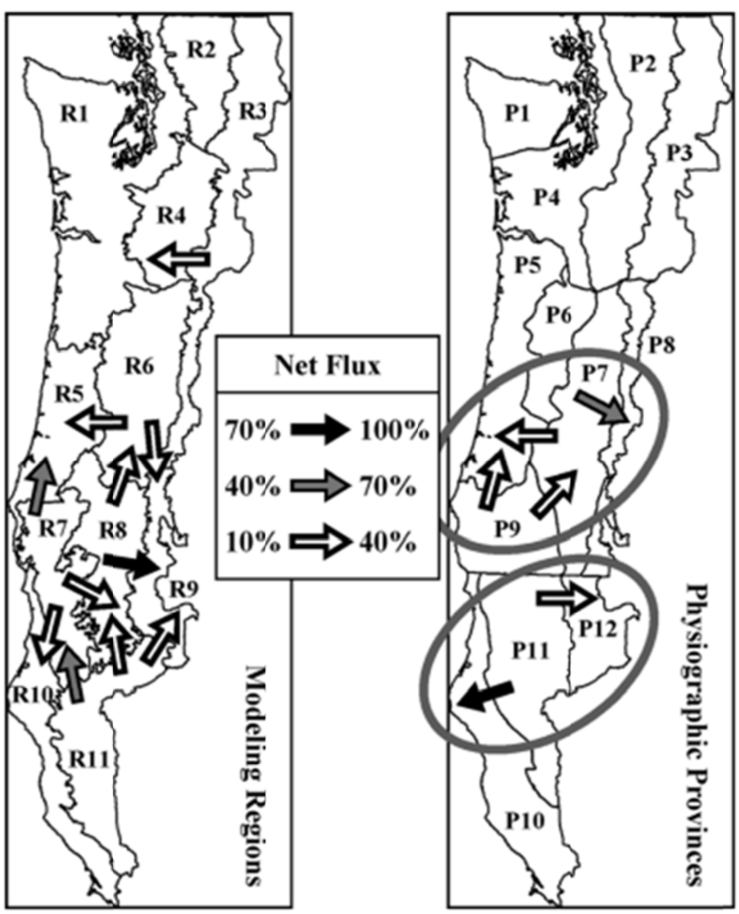
Figure 6: Modeling regions in California described in the 2011 Revised Recovery Plan for Northern Spotted Owls.
Figure 7: Locations of 11 Northern Spotted Owl demographic study areas used to assess vital rates and population trends.



~~**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.

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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.

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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).

Figure 17: Changes in dispersal-capable landscapes across the Northern Spotted Owl's range (Figure 3-17, Davis et al. 2011). What is the timeframe for these changes?

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Figure 19. Marijuana cultivation locations from 2011 and 2012 within the watersheds Upper Redwood Creek, Redwood Creek South, Salmon Creek, Outlet Creek and Mad River Creek in Humboldt, Trinity, and Mendocino counties, overlaid with owl activity center locations.

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).

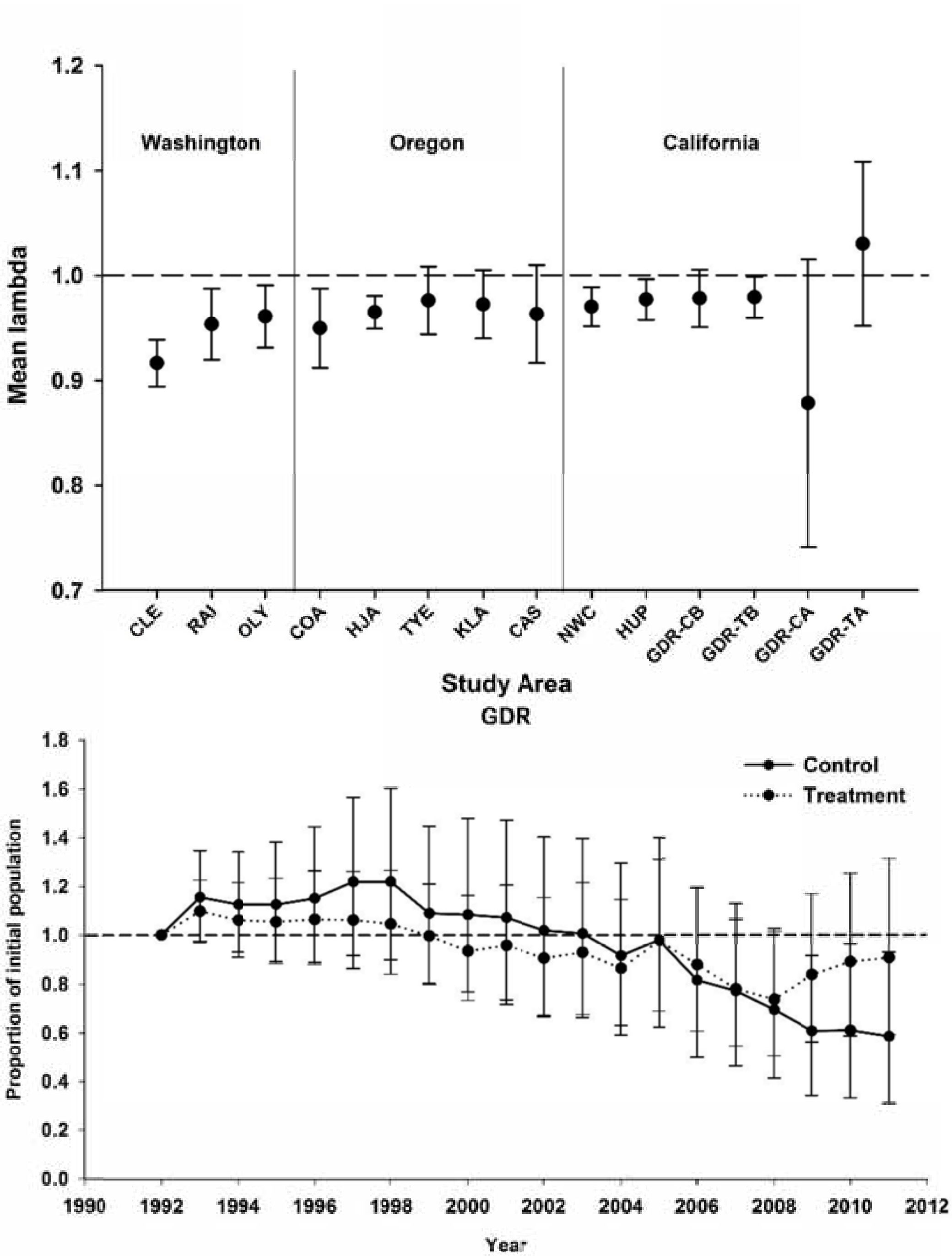
Figure 25. Percent change in precipitation within the Northern Spotted Owl range in California. Maps show both 30 year & 5 year averages

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,

Lowell V. Diller

Lowell V. Diller, Ph.D.
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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.

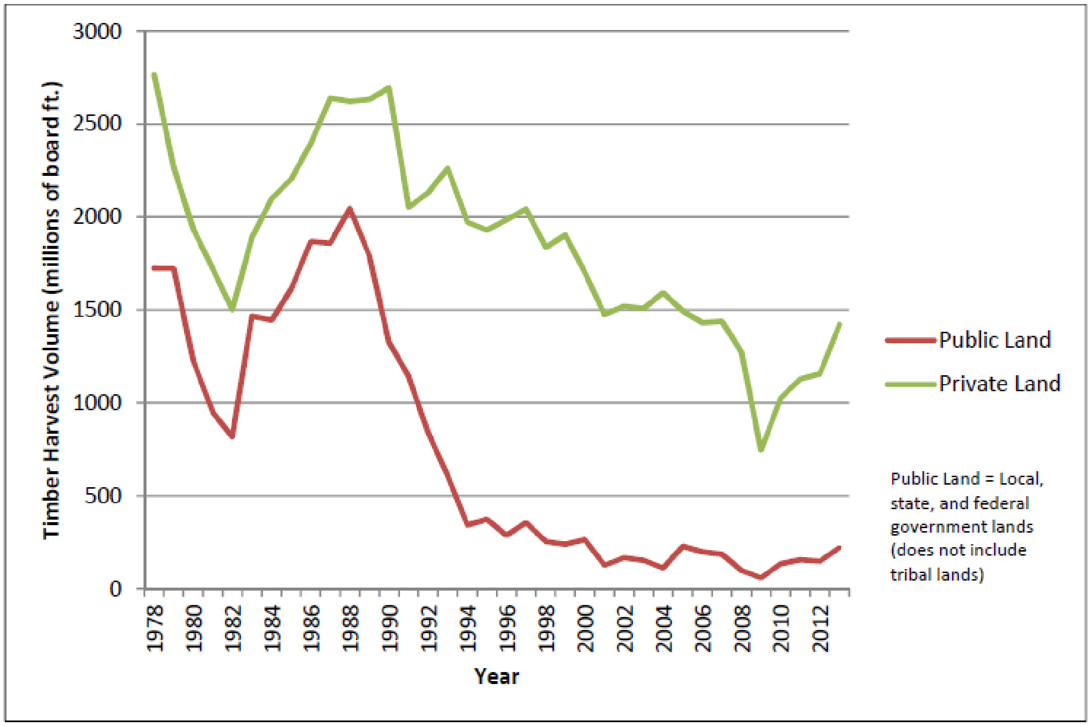
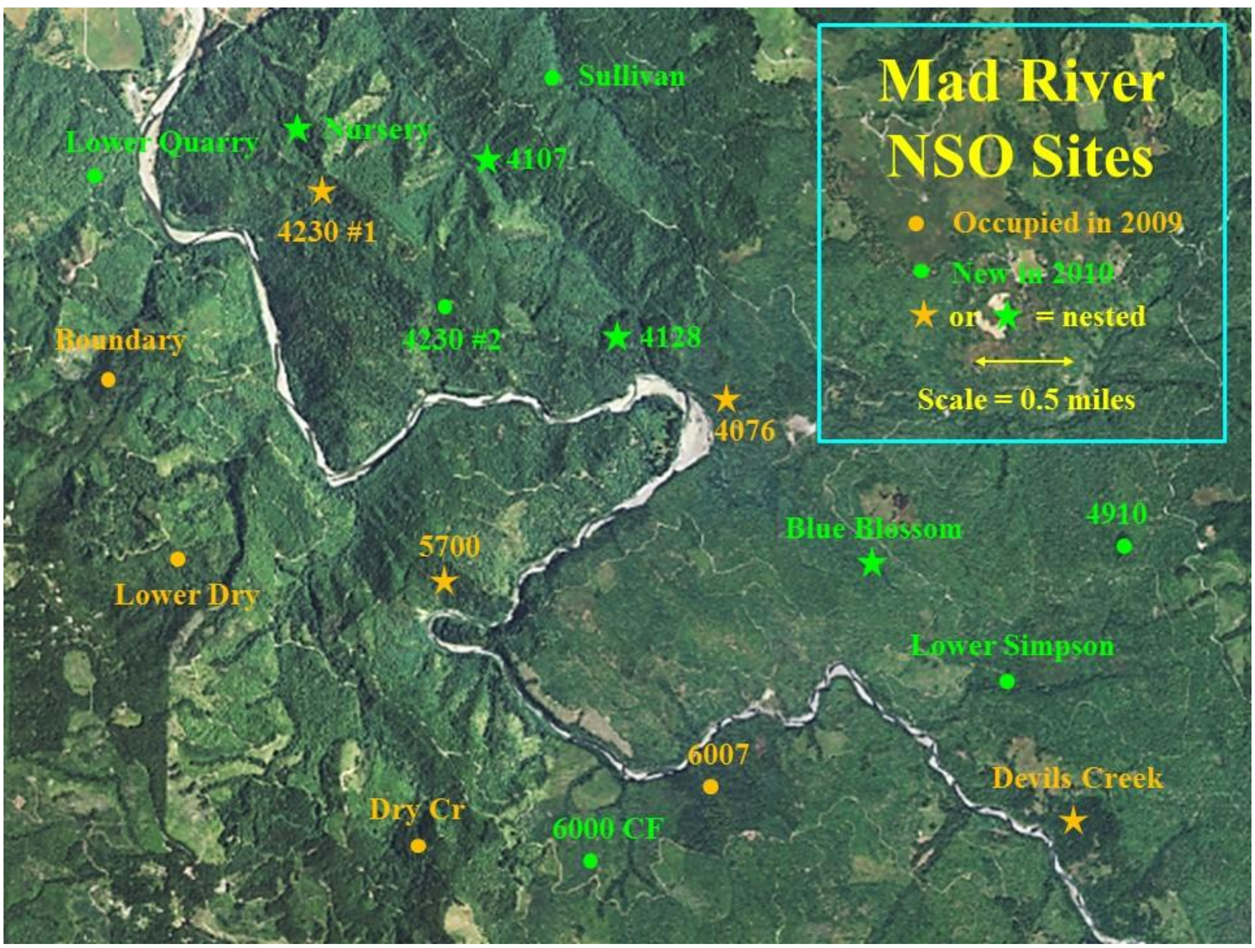


Figure 15. Volume of timber harvested on public and private lands in California (1978-2013) (California Timber Harvest Statistics n.d.).

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

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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

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, section2074.6, 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.

This written status review report indicates, based upon the best scientific information available, whether the petitioned action is warranted, preliminary identification of ~~es~~ habitat that may be essential to the continued existence of the species, and recommends management activities and other ~~recommendations~~ activities 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.

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.

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.

> 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, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.

> 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 such migratory nongame bird except as provided by rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory Treaty Act.

California Board of Forestry and Fire Protection

The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire Protection (CAL FIRE) have designated Northern Spotted Owl as a “Sensitive Species” as identified in the California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules). These sections also define Northern Spotted Owl -related terminology, including “activity center”, “Northern Spotted Owl breeding season”, and “Northern Spotted Owl Evaluation Area.” Specific requirements for the disclosure of information on Northern Spotted 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 sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and related activities, would be avoided according to the criteria for determining take avoidance found in Section 919.10. Other 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 nests through buffers and avoidance of sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the protections afforded to late successional forests, which are a component of Northern Spotted Owl habitat.

International Union for Conservation of Nature

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

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~~ gene~~tic~~ 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, 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 t~~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).

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).

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).

Comment [DK4]: You will be able to cite Dugger et al. (2015) very shortly – NSO manuscript detailing status and trends is now "in press".

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 km^2 (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

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/northen-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.

nesting 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~~ Individual Spotted Owls do not always breed every year, and strong biennial patterns in breeding propensity and reproductive success are observed throughout their range (Anthony et al. 2006, ~~but more normally breed every other year (~~Forsman et al. 2011, Dugger et al. In press). 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), although recent research suggests the costs of reproduction are not responsible for these patterns in California Spotted Owls ~~2011~~(Stoelting et al. 2015). Annual variation in reproductive success may ~~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 low productivity by young birds (<3 years of age) ~~ng onset of breeding maturity~~ all contribute to low annual 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/km^2) 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/ km^2 of habitat) at 0.544 owls/km^2 (95% CI = 0.495-0.592) and 0.660 owls/km^2 (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km^2. 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/km^2±0.006, 0.351 owls/km2±0.011, and 0.313 owls/km^2±0.017 for Klamath, Korbel and Mad River regions respectively, with an overall mean density of 0.209 owls/km^2±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbel, 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/km^2 in the northern portion of their land in Humboldt County, and 0.78 owls/km^2 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 exists?).

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).

portions. Sierra Pacific Industry reported 0.450 owls/km^2 between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km^2 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/km^2 of area surveyed (MRC 2014). Lastly, Humboldt Redwood Company (HRC) reported 1.22 occupied territories/km^2 and 2.23 owls/km^2 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?

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.

Basal metabolic rates (BMR) of ~~Metabolic measurements made on~~ California Spotted Owls are very low relative to BMR for other owl species (~~in~~ Weathers et al. ~~(~~2001), ~~showed very low basal metabolic rates compared to other owl species, thereby leading to~~ suggesting very low energy requirements for Spotted Owls. 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 (Weathers et al. 2001). Similar work has not been conducted for Northern Spotted Owls. ~~This low metabolic requirement is likely similar to that of Northern Spotted Owls, though no known study has been 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 -

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 m^2/ha basal area (Irwin et al. 2013).

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……

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 [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 Kernal, and Adaptive Kernal) 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 c~~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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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 Kernal, and AK = Adaptive Kernal.

	Annual Home Range in hectares (+/- one Standard Error)					
Area	MCP	MMCP	95% FK	95% AK	Core area in hectares	Source
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

Dispersal

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

In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent 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 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). While the only data available on dispersal pertains to Northern Spotted Owls in Washington and Oregon, and California Spotted Owls in California, we can extrapolate that Northern Spotted Owls in California act similarly, because, while the populations are genetically and geographically distinct, they still share many ecological and behavioral characteristics.

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

Habitat Requirements

Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al. 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 some portions of the species' range (Franklin et al. 2000).

Comment [DK22]: Never found to be important farther north than mid-Oregon.

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 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.

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 Gutiérrez1999, 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."

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

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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 (tress >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 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry

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 (Gutiérrez1996, 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).

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).

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 diameter[1] 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 m^2/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 (but see Dugger et al. 2005), as certain habitat types that border older forest may contain 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.

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).

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.

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 [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 -

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."

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.

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 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.

<u>California Coast Province</u>

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 then 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 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.

Comment [DK29]: Citations to support this statement (??)

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

<u>California Klamath Province</u>

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

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

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

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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

			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	nesting-roosting habitat: for most locations average DBH >17 inches and average conifer canopy cover >60%; foraging habitat: in all locations average DBH >9.8 inches and average conifer canopy cover >40%, additional criteria in some locations

California Cascade Province

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

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

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

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

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

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

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

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

Habitat Effects on Survival and Reproduction

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).

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

Comment [DK31]: Actually, coming up with specific thresholds that can be generalized across the species' range has been really hard……

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 t~~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 change[2]) 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

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

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,

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 ≥40%, and overstory canopy coverage of ≥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).

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

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

[a]Size 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.

[b]Size 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.

[c]Franklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types.

[d]Edge 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.

[e]Franklin 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

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 m^2/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

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.

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, w~~W~~ithout 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~~

Comment [DK38]: See my comments above about density.

Comment [DK39]: This one is CA Owl, but provides strongest evidence of this breeding effect.

~~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.

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.

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~~al 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.

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 where long-term research is conducted 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.

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

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

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
Washington				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
Oregon				
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
California				
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.

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.

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

Comment [DK46]: See Dugger et al. 2015.

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 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.

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]
Washington				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
Oregon				
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
California				
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

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).

Comment [DK47]: In press! (finally)

Fecundity and Survival

Comment [DK48]: See Dugger et al. 2015

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

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

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

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

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.

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

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).

Comment [DK50]: These are very good points that I think we do try and make in the Discussion of Dugger et al. (2015)

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 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).

In contrast to the above studies at demographic study areas and at other well-monitored areas that showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the 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.

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.

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.

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.

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 survey 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

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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 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.

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……

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.

Comment [DK55]: Isn't this an analysis conducted by AJ Kroll? I thought he had an manumscript in progress – or was it on the Mendocino Co. lands below?

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 survey methods used~~, by companies,~~ ~~the tendency to~~ reports of ~~n~~ counts or naïve estimates of occupancy without consideration of detection probability, the sometimes inconsistent methods used over time, and ~~along with~~ the sometimes limited description of methods, means there is little support for the timber Industry's conclusion that occupancy rates have been stable across ownerships over time. ~~akes 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.~~

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…..

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.

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.

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

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 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
Modeling Regions			
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
Physiographic Provinces			
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 to the California Coast Range, California Cascades and Oregon Klamath provinces, with net flux most notable to the California Coast Range province.

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

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
	Modeling Regions		
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
	Physiographic Provinces		
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

~~Schumaker et al. (2014) results suggest that~~ Thus, California's population of Northern Spotted Owls is a significant component of, and source to the range-wide population (Schumaker et al. 2014). As a source, the Klamath region populations provide a source of owls to sink populations on the Coast and Cascade ranges. This concept is central to protection of owl habitat, especially dispersal habitat, for the 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).

Existing Management

Land Ownership Patterns in Northern Spotted Owl Range

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

Comment [DK59]: Probably wise to include something about "meeting needs for forest products" or something like that .....

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.

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.

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)
Total	*24,465,790 (100)*

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. However, silviculture treatments (including thinning in stands less than 80 years old west of the Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district plans as being withdrawn from timber production and include recreational and visual areas, back country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with smaller amounts of reserved lands on the coast (Figure 11).

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

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

<u>Late Successional Reserves:</u>

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

- 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:

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.

<u>Adaptive Management Areas:</u>
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
- Retention of large snags and down logs within thinning units
- Retention of hardwoods
- 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-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.

<u>King Range National Conservation Area</u>

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

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

National Park Service

Redwood National and State Parks

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

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

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

Prior to timber removal, the NPS will evaluate trees that are potential suitable nesting habitat for Northern Spotted Owl. The NPS take measures to reduce noise disturbance and loss of suitable habitat within one mile of occupied and unsurveyed potential suitable nesting habitat by operating outside the breeding season, using quiet equipment, or by implementing daily limited operating periods for heavy

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equipment during the breeding season. Protective buffer zones are used around known owl nest sites where visitor use activities are likely to result in disturbance.

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

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

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

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

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

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

Point Reyes National Seashore and Muir Woods National Monument

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

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

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

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

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

- Treatment activities or any noise generation above ambient noise levels will not occur within 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as surveys conforming to accepted protocol have determined that the site is unoccupied or non-nesting or nest failure is confirmed.
- Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially alter the percent cover of canopy overstory and will preserve multilayered structure. When shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy

will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency vehicle clearance.

- Prior to fire management activities, project areas will be surveyed for the presence of dusky footed woodrat nests. If feasible, woodrat nests will be protected.
- Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a determination is made that the native tree presents a clear hazard in the event of a fire or cutting is the only option to reduce high fuel loading.
- The fire management officer will arrange for qualified biologists to conduct post-project monitoring to determine short- and long-term effects of fire management actions on activity centers if resources are available.

Tribal Lands

Hoopa Valley Indian Reservation

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

The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late successional reserves to the north, south, and east, and Redwood National Park to the northwest. The reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40 pairs of owls at all times during the planning period. However, the plan notes this number of Northern Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

Eight forested management units noted in the FMP will retain Northern Spotted Owl dispersal habitat. None of the forested management units will dip below 50% cover of dispersal or higher quality habitat.

The lowest level of owl habitat retention will occur within the Hopkins management unit, which at 72% at the time of the publication of the FMP, was projected to drop to 64% in 2012 and increase to 81% by 2026.

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

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

Yurok Indian Reservation

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

The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for intensive surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites. The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on disturbance activities within 0.25 mile of Northern Spotted Owl nest.

Round Valley Indian Reservation

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

Nonfederal Land

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

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

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

A Timber Harvesting Plan (THP) is generally the environmental review document submitted by landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment. THPs are prepared by Registered Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These biologists would become the first "designated biologists" who would consult on proposed THPs.

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Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules and procedures that would be adopted in the event of listing. The rules identified descriptions of Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for timber operations to avoid take. The rules called for consultations between plan proponents and Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to amend the initially adopted emergency rules; amendments to the rules occurred several times as knowledge of the Northern Spotted Owl increased and with experience gained through implementation of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] in March 1991, 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.

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

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

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

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

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

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

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

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

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

Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol, breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol was revised (USFWS 2012).

When consultations with the USFWS were required, they consisted of a field review of the proposed THP area, an evaluation of the pre-harvest and predicted post-harvest habitat typing (its suitability for nesting, roosting, or foraging), the sufficiency of habitat retained post-harvest within 500 feet, 0.7 mile and 1.3 mile of owl ACs, and an evaluation of the adequacy of the surveys that were conducted (i.e.

timing, location, interpretation of results) and their consistency with the USFWS protocol. When appropriate, the Department designated biologists would evaluate or propose THP-specific habitat and temporal buffers that differed from standard Forest Practice Rules habitat retention and seasonal restriction requirements that would be adopted as enforceable conditions of THPs.

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

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

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

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

- Other emerging and compelling forestry sector conservation issues required Department staff’s attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related workload).
- The Department “Timber Harvest Assessment Program” (later to become the “Timberland Conservation Planning Program”) budget did not include funding specifically for consultations.
- Staffing of USFWS offices with wildlife biologists had increased.
- The Department felt CAL FIRE and USFWS staff were capable of review, approval, and assessment of THPs and NTMPs.
- The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- The scope, quality and conformance of owl-related information with Forest Practice Rules requirements appeared to have stabilized after approximately six years of implementation.

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

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

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

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

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

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.

13 THPs from Interior Counties	Acres	62 THPs from Coastal Counties	Acres
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

habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat from Forest Practice Rules guidelines.

Forest Practice Rules guidelines under Option (g) are:

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

The USFWS (2009) recommendations are:

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

As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option (e) 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 six interior THPs, four primary habitat types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-habitat.

Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior, and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within 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; 47,344 acres of nesting and roosting).

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).

	6 Interior THPs associated with 14 activity centers, Option (e)		60 Coastal THPs associated with 132 activity centers, Option (e)
	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

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).

	7 Interior THPs associated with 8 activity centers, Option (g)		2 Coastal THPs associated with 6 activity centers, Option (g)
	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

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.), 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.

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.

		Interior, Option (e) Acres harvested		**Interior, Option (g) Acres harvested**	
Activity Center	**Range of Harvest Years**	**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

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

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

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

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

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.

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

Table 17. Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years 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**
Interior Counties 1991-2014					
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
Coastal Counties 2005-2014					
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**

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

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**
Interior Counties 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
Coastal Counties 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**

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

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

The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear that some information was not available to the reviewer due to the nature of the older NTMP narratives, limited public information, and subsequent amendment submissions. There is simply no effective way to track this information in an analysis going back in time. Though Selection and Group Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range, we can infer that owl habitat is retained to some extent; however, we could not 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.

Spotted Owl Management Plans

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

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

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

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

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

<u>Spotted Owl Resource Plans</u>

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

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

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

<u>Habitat Conservation Plans</u>

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

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/mi^2 and 0.32 owls/mi^2, 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

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

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

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

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

According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the

understanding of suitable owl habitat was limited. In 2006, GDRC submitted an application to the USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes the Project, requires the Applicant to comply with terms of the amended BO and its associated incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified the Department that the BO was issued and requested that the Department issue a consistency determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1. In January 2014, the Department found that BO, 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 2014a).

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

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

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

Northern Spotted Owl management objective outlined in the plan include:

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.

Northern Spotted Owl conservation measures outlined in the plan include:

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.
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.
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 31site 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.
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.

Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable owl habitat must be provided, if present, and less than 50 percent of this shall be under operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided, within 1.3 miles of each activity center.

5. Designate additional owl activity sites as "Level Two" habitat retention sites by September 1 of each year to make up the minimum number of activity centers designated by the HCP. "Level Two" habitat retention must 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. Following the breeding season, 18 acres around the AC shall be maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC must the in place. For sites, which have been determined to be occupied by a non-nesting pair or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and a 400 foot radius buffer protecting the activity center must the in place. Harvesting of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat retention area.

6. Activity center that are not needed to meet management objectives above shall receive "Level Three" protection measures. These activity centers shall have a 1,000-foot buffer during the breeding season. Timber harvest associated may occur before March 1 or after August 31. During the breeding season, for activity centers which have been determined to be occupied by a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur during the breeding season in the area adjoining the 18-acre habitat retention area.

7. All nest trees shall be marked and be retained if the activity center is harvested.

The HCP outlines an objective to conserve habitat diversity and structural components within the plan area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types and seral stages are maintained across the landscape over the permit period, as well as structural components, to contribute to the maintenance of wildlife species covered under the plan, including the Northern Spotted Owl.

Structural components to be retained include:

1. A certain number and size snags that do not pose a human safety hazard.

2. A certain number and size of green replacement trees, if snags are not present, with a priority for trees other than redwood.

3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or cavities.

4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a maximum of two per acre.

5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given to logs over 30 inches in diameter.

In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in fact 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 2014b).

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

- Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and federal governments to ensure their functions as wildlife reserves in perpetuity.
- Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting habitat in a series of Marbled Murrelet Conservation Areas (MMCAs).
- Conduct a combination of night and daytime surveys and stand searches to locate both known, and any new, owl activity centers.
- Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other conservation elements of the HCP for the retention and recruitment of potential foraging, roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
- Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 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.
- Conduct complete annual censuses to monitor all activity centers on the ownership and to determine numbers of pairs, nesting pairs, and reproductive rates.
- Survey the THP area and a 1,000-foot buffer for new operations, except site preparation, initiated in the period beginning February 21 and ending on or before August 31.
- Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and detection probabilities using accumulated survey data.
- Submit annual reports describing the activities undertaken, results of the Operating Conservation Program, and the proposed Operating Conservation Program activities for the next year for all lands covered by the HCP.

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

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

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

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

Terra Springs LLC HCP

The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa County west of the city of St. Helena, and is located within the California Coast Province. The plan has a 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting, roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees, felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices, retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous

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

federal and private lands have shown that many activity centers are located on or have a home range that extends onto the FGS ownership.

Safe Harbor Agreements

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

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

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

Forster-Gill, Inc., Safe Harbor Agreement

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

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

- Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
- Retain all snags not posing a hazard risk.
- Conduct annual owl surveys on property and within a 500 foot radius around the property.
- Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
- Ensure no harvest occurs within 1,000 ft of any active owls nest site.
- Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and approved by USFWS.
- Conduct timber stand inventories and provide USFWS with data.
- Allow USFWS or other agreed-upon party access to property for monitoring and management 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.

<u>Exemption Harvest</u>

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

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

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

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

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

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

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

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

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

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

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

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

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

The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet from any point of an habitable structure that complies with California Building Code for the purpose of reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2, 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project area shall be increased in the post-harvest stand.

During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS, approximately 41,767,250 acres (1992 to 2013) have been exempted for harvest in counties within the

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.

<u>Emergency Harvest</u>

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.

- Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood, landslide, or earthquake.
- Dead or dying trees as a result of air or water pollution.
- Cutting or removing trees required for emergency construction or repair of roads.
- Cutting and removal of hazardous fuels.
- Treatments to eradicate an infestation of Sudden Oak Death.

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

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

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

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

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

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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Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak woodlands and prairies is managed through tree removal and burning. Nine management zones within the RNSP delineate the degree of human influence and development on that can occur on the landscape (NPS 2000a).

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

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

University of California Natural Reserves

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

Department Ecological Reserves

Authorized by the California Legislature in 1968 and administered by the Department, the ecological reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats, and to provide areas for education and scientific research. The system now encompasses 119 properties totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur within the range of the Northern Spotted Owl; however there are no management plans for the system or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by BLM, which manages for late seral habitat benefiting Spotted Owls.

Fisheries Restoration Grant Program

As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern Spotted Owls and their habitat are required for each project funded. The purpose of FGRP is to support restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must

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

large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat (see Figure 4).

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

Assessing Habitat Loss through Implementation of the Northwest Forest Plan

The Northern Spotted Owl was listed under the federal Endangered Species Act in 1990 in part because of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls, ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or degradation from stand replacing wildfire and other disturbances, and loss of amount and distribution of Spotted Owl habitat as a result of past activities and disturbances (USFWS 2011a). To address ongoing decline of Northern Spotted Owl habitat across the range, the NWFP established reserved lands including late-seral reserves, adaptive management reserves, congressionally reserved lands, managed late-successional areas, and larger blocks of administratively withdrawn lands (USDA and USDI 1994) (Figure 11). These are described in more detail above. It was assumed that habitat in reserves would improve over time as successional processes led to more mature forests, however, this is a slow process and so recruitment of habitat conditions on reserves was expected to take many decades (citation?). It was also assumed that habitat outside of reserves would continue to decline due to timber harvest and other disturbances but that dispersal habitat would be maintained in order to facilitate movement between reserve lands (citation). Given the continued Northern Spotted Owl population declines and the increasing threat of the Barred Owl, the revised recovery plan recommended conserving occupied sites and unoccupied, high-value Spotted Owl habitat on state and private lands wherever possible (USFWS 2011a).

In order to understand the degree to which the NWFP contributes to conservation of owl habitat, the rangewide trends in habitat are regularly assessed. To date, assessments have been performed at the 10-year and 15-year time points (Davis and Lint 2005, Davis et al. 2011). The recent assessment estimated rangewide habitat changes on federal and nonfederal lands from 1994 through 2007 for California and from 1996 through 2006 in Oregon and Washington by comparing vegetation maps for two bookend time periods. In addition to rangewide changes, trends for each physiographic province and for each state are also reported (Davis et al. 2011). The assessment tracks changes in Northern 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/

between the reserves. Foraging habitat is not assessed through modeling for the NWFP. Nesting and roosting habitat maps were produced through habitat suitability modeling using several forest structure variables (e.g., percent conifer cover, average conifer dbh, average stand height) and a forest age variable (Davis et al. 2011). Vegetation stands were placed in one of four categories (highly suitable, suitable, marginal, and unsuitable), with highly suitable and suitable categories assumed to represent nesting and roosting habitat (Davis et al. 2011). To assess change, an area was considered to have lost nesting and roosting habitat if its condition moved from suitable or highly suitable to marginal or unsuitable.

Comment [DK63]: Update all of this based on Davis et al. 2015

Although federal lands contain less than half of the total forest land within the entire range of the Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on nonreserved lands.

Comment [DK64]: Also new old growth forest report – Spies and Davis I think. Draft should be on the web site listed above.

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

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

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

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

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

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 change)(USFWS 2009)~~did not change pair status~~. These results suggest inefficiency in rules guiding timber harvest for the protection of Northern Spotted Owls.

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?

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 by~~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 i~~I~~n 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 trees retained ~~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, for example, hardwood must be retained at such a level as to ~~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 as per the "Hardwood Cover" evaluation requirements of the Cumulative Impacts Technical Rule Addendum #2 (CCR 912.9, , 932.9, 952.9 (c)(4)(e).

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?

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 some specimens are retained, presumably providing ~~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), 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, Bignham 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 varies from 30-60%, with an average of about 45% (USFWS 2009). For a more detailed discussion on core and home range use, see Biology and Ecology section of this report.

As discussed in the Habitat Requirements section of this report, 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; Franklin et al. 2000). See the Habitat Effects on Survival and Reproduction section of this report for a discussion of HFP and additional studies that have contributed to an understanding of habitat characteristics that provide high HFP. The studies that have evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent 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.

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

The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory loss. They found on private timber lands there was a 54% decline in pair status to no response, and a 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change 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.

survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat characteristics to owl fitness, the USFWS asserted that the Forest Practice Rules were insufficient to 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

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.

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.

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, becaseu 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).

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).

Comment [DK73]: IS this right? Feet not meters? So 167 meters? That seems ridiculously close to the core of an owl territory.

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			

[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.

Table 22. 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 interior region of 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.

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 with the passage of ~~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 form 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

Comment [DK74]: How about a potential effect on demographics directly through toxicity associated with herbacides 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.).

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

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 i~~an 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 ~~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 of the spotted owl. In addition, smaller clearings (less than 10 mi^2) are likely not captured in the dataset due to difficulties identifying and delineating smaller sites using aerial imagery and not all site~~s~~ 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 number of sites unaccounted for is unknown. ~~it is still uncertain how many 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, or the use of pesticides and insecticides to increase crop yield.

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~~2015).

Comment [DK75]: I believe the current report essentially concludes the same thing.

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~~in eastern Washington and southern Oregon for the Northern subspecies, in the Sierra Nevada mountains for ~~in the range of~~ the California Spotted 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 -

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 wildfire~~s~~ on spotted owl demographics, and the extent and quality of suitable ~~Spotted Owl~~ habitat. ~~Results of studies on T~~the effect of fire on occupancy rates of ~~by~~ Spotted Owls has ~~ve~~ 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.

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.

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.

Comment [DK81]: Update incorporating additional Lee and Bond citations.

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

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 ≥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).

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.

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

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

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

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).

~~Regardless of methodology used, ~~Aall 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 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 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

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.

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 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 beginning in the 1980’s (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 declined from a high of 974 years in the early 1980’s ~~fell~~ to 95 years by 2008, ~~(from a high of 974 years in the early 1980s)~~. ~~As noted in Figure 24, t~~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 (Figure 24; 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 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~~ suggest~~s~~ 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~~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 these years due to the long duration of fires, weather conditions, and strong inversion events (Miller et al. 2012).

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.

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.

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 (citations…). 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.

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.

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 (citation?). 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).

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

Several studies have determined a strong link between changes in fire extent, severity and season, with low precipitation and high temperatures. In addition to land-use history over the last century, climate 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.

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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 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: habitat availability, 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 (citations?). Although forest heterogeneity has decreased with recent management practices, the forests of the Klamath Mountains continue to provide habitat for Northern Spotted Owl. Thus, m~~M~~ore information is needed on the effect of historical fire suppression and current fire regimes on the amount and quality of current owl habitat~~, especially on the quality of habitat~~ as assessed through demographic rates on ~~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 (citation). However, recent large fires are cause for concern ~~for the future stability of forest conditions in the region, especially~~ considering the higher percentage of remaining suitable owl nesting and roosting habitat 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

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.

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%).

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 demographic~~s~~, 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 exceed~~i~~ed ~~ng rates~~amounts of old-forest burned in ~~o~~f 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 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 that 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.

Comment [DK94]: Reorganize and condense by "theme" rather than by study? Maybe a section on temperature, then another for precip?

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 ~~McIntrye 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 120,000km^2 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, increase~~s~~d in productivity along the coast can ~~would o~~only occur ~~be seen~~ if ~~there was a persistence of~~ coastal summer fog persists (Lenihan et al. 2003). ~~Lenihan et al. (2003) suggests that I~~if summer fog were to decrease in conjunction~~cert~~ 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), o~~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.~~

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~~(2012) effectively summarizes t~~The nationwide effects of climate driven disturbance can be summarized as follows (Vose et al. 2012):

- Frequency and extent of w~~W~~ildfire will increase, resulting ~~causing~~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 f~~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~~, exacerbat~~e~~ing 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 b~~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 class, whereas inland regions are drier and warmer and tend 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 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. 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 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 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must include structurally complexity to provide nesting options with proper protection. The intensity of disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may increase the level of structural complexity.

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

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

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

Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-August) and winter months (December-February) separately. Comparing the 30-year average with the 5-

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 sever 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, Barrowclaugh 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. A~~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

(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.~~ Regardelss of w~~W~~hether 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 1,970[3] 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 s~~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.

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)., b~~B~~oth 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~~E~~xplanations 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 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 harvest~~s~~ 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 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 (Gutiérrezet 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 (Gutierrez et al. 2007, Dugger et al. 2007, Wiens et al. 2014, Singleton 2015). ~~(Gutiérrezet 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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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)~~. Regularly conducted meta-analysis ~~These~~ workshops incorporating long-term demographic data for up to 14 study areas across the range of the owl have resulted in ~~four~~ five published and one unpublished meta-analyses since 1994 (Burnham et al. 1994, 1996, Franklin et al. 1999, Anthony et al. 2006, ~~and F~~Forsman et al. 2011, Dugger et al. in press~~)~~). 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; Anthony et al. 2006, Forsman et al. 2011, Dugger et al. in press). 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.

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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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, Yackulic et al. 2012, 2014, ~~-~~Sovern et al. 2014). ~~Studies have shown that~~ Barred Owl presence negatively influences whether Spotted Owls occupy a territory (Kelly 2001, Pearson and Livezey 2003, Gremel 2005, Olson et al. 2004, Kroll et al. 2010, Dugger et al. 2011, Yackulic et al. 2012, 2014, 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 Owl activity centers will shift ~~move activities~~ away from areas where ~~ith~~ Barred Owls are present ~~ce~~ even if they do not entirely abandon ~~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).

Comment [DK106]: Doesn't telemetry data from Wiens et al. 2014 also suggest this?

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.

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 a. 2015). Spotted Owl territories having Barred Owl detections ranged between 0-37 within the same timeframe (Franklin et al. 2015).

Comment [DK108]: This is now available as published information in Dugger et al. in press.

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 demonstrating~~es~~ 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). When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed (Diller 2012).

Comment [DK109]: See additional information re: demographic responses of removals on GDR (in particular lambda) – rest of the removal experiment on GDR in currently undergoing review with JWM.

During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97% adutls, 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 at 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 (Gutiérrezet al. 1995, Mazur et al. 2000, Gutiérrezet 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, Dugger et al. in press).

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).

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 -

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 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.

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.

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~~ tested 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 infestation, 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.

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.

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 ~~. S~~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.).~~

Comment [DK114]: I think this is the point right? Birds can carry the blood parasites with no apparent clinical symptoms?

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).

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

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.

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.

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.

Contaminants

Northern Spotted Owls feed on a variety of prey species, but mainly small mammals make up a bulk of their diet (e.g., Forsman et al. 2004). 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 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 bromadiolone) 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).

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.

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~~ whether morbidity and mortality is widespread for the California Spotted Owl, or if poisoning is also occurring (and at what level) in Northern S~~for the s~~potted owls ~~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 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~~ T~~t~~he use of rodenticides (prevents damage to young trees from rodents browsing) or herbicides (suppresses shrubs to allow growth of trees) in burned forests might pose a ~~and the~~ potential threat ~~of these substances~~ to Spotted Owls through the ~~. The use of herbicides and rodenticides may~~ reduction in ~~e the~~ prey habitat and subsequently, abundance for Spotted Owls (Bond et al. 2013). H~~, h~~owever 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 anticoagulants ~~rodenticides~~, which are not as persistent or toxic in their target species as other types of rodenticides (S. McMillin, personal communication, September 25, 2014).

~~In i~~In contrast, illegal marijuana grows are ~~,~~ widespread in the Northern Spotted Owl range and ~~,~~ 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 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.

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 that BO in the same habitats. Although if NSO are eating "mostly" woodrats, then maybe BO are reasonably representative?

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytopthora 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. *Phytopthora 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 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 (m^2/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).

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 course 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 (Tempel 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 course 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,

> "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).

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.

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 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance with the presence of hikers (Swarthout and Steidl 2003).

It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the level to which these activities may impact owl behavior, reproduction and overall survival 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

There had previously 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 provides compelling evidence that a population bottleneck may have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from 352 Northern Spotted Owls from six regions across the range which included limited samples from the northern portion of the California Klamath Province.

> Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades) bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic variation and hence effective population size, do not necessarily indicate a decline in actual (demographic) population size (Funk et al. 2010) "… it is important to keep in mind that reductions in [effective population size] (detected with bottleneck tests) are different than reductions in demographic population size (detected with demographic field studies) and reductions in one of these parameters does not necessarily result in a change in the other." (Funk et al. 2010)

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 implementation of the NWFP show that habitat loss on federal and private lands is ongoing. Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land, whereas ~~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 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the broader home range (1.3 mile radius).

The most recent research on Northern Spotted Owl habitat requirements in California and southern Oregon have demonstrated a link between owl fitness and the amount of different habitat types, ~~of habitat,~~ structural characteristics of habitat, and the spatial configuration of habitat types in owl ~~a~~ home ranges. This requirement for habitat heterogeneity is consistent with the general approach incorporated in the Forest Practice Rules. Although study design has varied across the major research studies, some consistent patterns have arisen. In order to support productive Spotted Owl territories, a minimum amount of older forest must be retained in the core area. The definition of 'older forest' evaluated in studies has varied, but consistently includes late-seral forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older forest in an approximately 400 acre core area.

Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness. Results indicate that in order to support a productive Northern Spotted Owl territory, no more than about 50% of a home range should consist of nonhabitat.

The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls. The total acreage of recommended retention in the USFWS guidance does not differ from that found in the Forest Practice Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range must be retained in habitat. However, based on assessment of core use areas in the interior portion of the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations in line with core use areas evaluated in recent work. The most significant change in the revised USFWS recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained near the core is consistent with the literature.

A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised USFWS recommendations (see Table 22 for the interior portion of range in California) shows large discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres). This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500 acres of spotted owl habitat that must ~~to~~ be retained within 0.7 miles and the total of 1,336 acres that must ~~to~~ be retained within 1.3 miles of an activity center can be composed of "functional foraging habitat" under Forest Practice Rules, a definition that is considered low quality foraging habitat by the USFWS. T~~; t~~herefore, there is no requirement under ~~in~~ the Forest Practice Rules for habitat beyond 500 feet of a nest tree to ~~this habitat~~ include nesting or roosting habitat ~~under the Forest Practice Rules~~.

Comment [DK123]: I agree - see comment far above about this.

Our assessment of selected activity centers shows that even the current habitat retention guidance in the Forest Practice Rules are not always met, indicating that harvest is impacting individual Northern Spotted Owls ~~at some locations~~on some private lands. Of the activity centers evaluated, several experienced very high acreages of harvest at both the broad home range and at ~~in~~ the core area scale, ~~which would have~~ resulting ~~ed~~ in territories that do not meet the USFWS recommendation for take avoidance, and which could have resulted in negative consequences on ~~would have resulted in declines 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.

Documentation of habitat type, amount, and distribution present around activity centers after THPs are implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if minimum retention requirements in the Forest Practice Rules are implemented as written, there is still the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts that have occurred in recent years.

The THP review and post-harvest follow-up process should ensure that the best scientific information is being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a sample of activity centers indicates that it is not universally applied and that insufficient habitat has been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

Salvage Logging

Several variables complicate the interpretation of owl response to fire, including variation in fire severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing and duration of research post-fire. Regardless, several studies 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. Although hampered by small sample size, incidental observations have documented declines in occupancy of burned areas following salvage logging. Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction probabilities, although the impacts of salvage logging were observed only in combination with other factors.

The presence of snags has been suggested as an important component of prey habitat and as perch sites for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub and herbaceous cover and number of snags, may be impacted by salvage logging.

Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the fire itself, by removing important structural elements and removing important prey habitat. The available information suggests that salvage logging reduces the probability that spotted owls will use burned areas and has resulted in declines in occupancy, either through abandonment or declines in survival.

Wildfire

Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994, after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to 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% -

The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to use burned areas extensively, although nesting and roosting general occurred only in unburned or low-severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

Conversely, occupancy rates for Northern Spotted Owls in southern Oregon ~~were shown to have declines~~ declined ~~in occupancy~~ following fire. These declines resulted from both high extinction rates in burned areas and low colonization rates.

Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to experience declines in survival. Food limitation in burned areas may have been a factor in declining survival rates. These observed declines in southern Oregon may be confounded by the occurrence of post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in the year following fire; these owls were not tracked to investigate potential longer-term effects.

Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance for foraging.

The available information suggests that wildfires can have positive effects on Northern Spotted Owls when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without removing important nesting and roosting habitat components at the territory scale. However, uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be used as a management tool.

Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades, fires have become more frequent and average fire size has increased. In some cases fires have also burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry and hot conditions). Because climate change will likely increase the likelihood of conditions that support fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

Climate Change Impacts to Forest Composition and Structure

Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate projection scenarios specific to California, the most notable response to increase temperature was a shift from conifer-dominated forests (eg., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g., Douglas fir-tan oak) in the northern half of the state~~)~~, expansion of conifer forests into the northeast portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-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

<u>Sudden Oak Death</u>

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.

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 steadily increasing. ~~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~~ illegal marijuana cultivation sites and the lack of reporting of legal cultivation sites, actual distribution and density of marijuana cultivation is likely larger and higher than current data suggests~~represented in datasets collected to date~~.

Comment [DK126]: What has increased? Total acreage under cultivation or number of growers or both?

Comment [DK127]: How is this "known"? Law enforcement data?

Activities associated with cultivation (e.g., removal of large trees, degradation of riparian habitat, use of rodenticides) may negatively impact Northern Spotted Owl habitat, although there is little 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.

Comment [DK128]: ?? Where does this information come from?

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 ~~is~~ reliable estimates across the range or within California, and does not effectively sample nonterritorial floater individuals. Northern Spotted Owl 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 slow process given tree species growth rate (with a possible exception on the coastal redwood forests), and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

One 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. 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 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The study 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. Three provinces located in California were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a stronghold for the population. Even though the complexity of the model may limit its ability to accurately model population estimates, the results suggest that California's population of Northern Spotted Owls is an important component of the range-wide population.

Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for more than two decades to assess demographic parameters such as population growth, survival, fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study areas range-wide. In California, the most recent meta-analysis covering years 1985-2008 reported a 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation study area reported a 2.3% population decline per year through 2012. When converting estimates for population change 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) two study areas in California (Green Diamond Resource Company and Northwest California) showed estimated population declines of about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The ongoing analysis has revealed declines in California between 32 and 55% over the study period.

Comment [DK129]: Revise following Dugger et al. in press.

In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in Washington and Oregon. Although less severe than in Washington and much of Oregon, all three California study areas show declines in survival.

Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in California give us information on current estimates for reproductive success (number of young fledged per monitored site) and survival, and are consistent with a continued decline within all demographic study areas in California. 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 despite weather conditions that would typically support good reproductive success. This was observed on many timber company lands, tribal lands, and National Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive rate since 2009.

The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study areas in California reflected trends on non-federal lands because two study areas are on non-federal lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal land. However, the authors also suggest that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands because the non-federal lands included in the demographic study areas are managed for owls. Results from the demographic study areas are thought to be 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 large, distributed across a broad geographic region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

Occupancy data is based on the presence or absence of owls from known sites. 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. Although an evaluation of occupancy rates has not been included in previous demographic meta-analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have declined at all three California study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on occupancy by increasing the local territory extinction rate.

Occupancy has been shown to be in decline for areas outside the California demographic study areas as well. For example, the southern Cascades and interior Klamath provinces of California determined occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

It is clear that ~~the declining~~ Northern Spotted Owl population declines ~~s~~ have not stabilized, and estimates of demographic rates across the range indicate the declines in demographic parameters, including population size, have in fact accelerated since the meta-analysis conducted through 2009. The level of decline does not seem to be slowing even with the implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at threats leading to these declines is warranted,

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.

Comment [DK131]: Substantially lower!!

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.

including revaluation of the effectiveness or management techniques across the Northern Spotted Owl range in California.

Predation

Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted Owls is not a threat to the population. In the case of documented Barred Owl aggression toward Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities were due to territorial aggression. Given that predation is not considered to be a major threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly manage predation issues.

Competition

Over the last several decades, Barred Owls have gradually moved further into the range of the Northern Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been present the longest (British Columbia and Washington), with fewer detections made in the southern edge of the range (California) where they have been present for a shorter duration. Currently, Barred Owls have been documented in all portions of the Northern Spotted Owl range throughout California, though densities of Barred Owls are unknown.

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.

Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong indication that the two species can coexist over time, sharing the same habitat and prey-base, because there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and not by Barred Owls.

~~Public workshops held by the USFWS have resulted in four published and one unpublished meta-analyses since 1994 to assess population parameters, such as abundance, trend, and survival.~~ 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 have been more prevalent where Barred Owls density was greatest.~~ Northern Spotted Owl adult survival has declined in a majority of the range where Barred Owls were present, with a more gradual decline noted in California largely attributed to the relatively more recent Barred Owl expansion into this portion of the range. Presence of Barred Owls in or near Northern Spotted Owl territories i~~s also thought to~~ negatively impacts fecundity, survival, and occupancy dynamics of Northern Spotted Owls.

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.

Experimental studies to remove Barred Owls conducted in California demonstrated that Northern Spotted Owl occupancy decreased~~s~~ with Barred Owl presence and increased~~s~~ 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.

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.

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 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and longer drier summers.

Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These studies indicate that winter precipitation is closely associated with a decrease in survival and recruitment; population growth was positively associated with wetter conditions during the growing season (May through October) and negatively associated with cold/wet winters and nesting seasons, and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction increased with late nesting season precipitation and decreased with warm temperatures; and owls may be more sensitive to changes in spring time climatic events.

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 sever 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 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where applicable. As new information becomes available, recommendations may be further refined.

Planning and Timber Practices

1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is consistent with the recovery of the species (see RA14).
2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-range planning, setting priorities for scientific research and investigations, and/or when making major decisions affecting the Northern Spotted Owl (see RA5).
3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative opportunities for nonfederal landowners to engage in management strategies (see RA15).
4. Consider long-term maintenance of local forest management infrastructure as a priority in planning and land management decisions (see RA16).
5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of Northern Spotted Owls (see RA21).
6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration, HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
7. Improve ~~thorough~~ documentation of harvest prescription methods within timber harvest plans (i.e.,. increase amount and detail of information), and conduct ~~a~~ rigorous evaluations of post-harvest levels of foraging, nesting, and roosting habitat.
8. Evaluate the effects of silvicultural practices on important Spotted owl prey species (e.g., flying squirrel, woodrat) and their required habitat.

Population Trend and Demographic Parameters

9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if the California population is decreasing, stationary or increasing (see RA2).
10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy across its California range (see RA3).

11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival, population growth and reproductive rates of Northern Spotted Owls in California, and determine if negative impacts of climate change outweigh the positive ones.

Habitat

12. Manage Northern Spotted Owl habitat in a way that accelerates the development of structural complexity and biological diversity that benefits Spotted Owl (see RA6)
13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl habitat) while allowing for other threats, such as wildfire and insects, to be addressed by restoration management actions (see RA32).
14. Conserve Northern Spotted Owl sites and high value habitat to provide additional demographic support to population dynamics (see RA10).
15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to inform decisions concerning the possible development of habitat conservation networks in California (see RA4).
16. Assess habitat requirements for, and barriers to, dispersal in California through research on Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and availability, and habitat modeling.
17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath Province) to assist evaluating landscape-level issues in the Provinces in California, including monitoring and adaptive management actions (see RA7 and RA9).

Wildfire

18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).
19. 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.
20. Conduct experiments to better understand how vegetation management treatments (e.g., thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern Spotted Owl habitat, prey abundance and distribution, and demographic performance (see RA11).
    a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in use of burned areas for foraging warrants additional research on long-term use of burned areas post-fire.

21. Gather information 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.

22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.

23. Develop a process for evaluating the likely effects of post-fire management activities, such as salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate this process into post-fire management decisions.

24. Concentrate post-fire silvicultural activities on conserving and restoring habitat elements that take a long time to develop, such as large trees, medium and large snags, downed wood (see RA12).

Barred Owl

25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy, reproduction, and survival in California (see RA23).

26. Promote experimental removal of Barred Owls within Northern Spotted Owl range, and if lethal removal is deemed a long-term management tool to manage negative effects of Barred Owls, explore methods for implementation within California (see RA22, RA29, and RA30).

27. Investigate the potential for resource partitioning of Barred Owls and Northern Spotted Owls (see RA26).

28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted Owl interactions.

    a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by the presence or absence of Barred Owls, but other unknown factors may also play a role.

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.

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 resource management agencies will allocate funds towards protection and recovery actions may increase.

Economic Considerations

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.

<u>Clearcutting</u>
Section 913.1(b) – Clearcutting regeneration method involves the removal of a stand in one harvest.

<u>Seed Tree</u>
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.

<u>Seed Tree Seed Step</u>
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)].

<u>Seed Tree Removal Step</u>
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).

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.

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

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.

<u>Commercial Thinning</u>
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.

<u>Sanitation-Salvage</u>
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.

<u>Special Treatment Area</u>
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.

<u>Rehabilitation</u>

Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7) prior to any timber operations on such lands, an area may be harvested provided it is restocked in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be included in the THP. The regeneration plan shall include site preparation, method of regeneration, and other information appropriate to evaluate the plan.

Fuelbreak/Defensible Space
Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a shaded fuel break or defensible space in an area to reduce the potential for wildfires and the damage they might cause.

Variable Retention
Section 913.4(d) - Variable retention is 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.

Conversion
Section 1100 – within non-timberland production zone (TPZ) timberland, transforming timberland to a nontimber growing use through timber operations.

Alternative Prescription
A written analysis of preharvest and postharvest timber stand conditions and a description of the silvicultural practices and systems to be used in lieu of the standard methods. 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.
Section 913.6 – When an Alternative method is used, the plan must include a statement of which silvicultural method in the current District rules is most nearly appropriate or feasible and an explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how the proposed alternative prescription will differ from the most nearly feasible method in terms of securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in terms of fire, insect and disease protection.

NonTimberland Area
Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land, other than land owned by the federal government and land designated by the board as experimental forest land, which is available for, and capable of, growing a crop of trees of a commercial species used to produce lumber and other forest products, including Christmas trees.

Road Right of Way
No strict definition

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

such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with characteristics of topographic relief and aspect which alter microclimates.

Functional Roosting Habitat during the territorial breeding season, consists of stands where average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers provide an average of at least 40% canopy closure but the stand can have a high degree of variability. Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for protection from various environmental conditions, including wind, heat, and precipitation.

Owl Habitat means Type A, B, or C owl habitat or those areas with functional foraging habitat, functional nesting habitat, and functional roosting habitat which support the owl's biological needs for breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls are known to occasionally inhabit less than optimal forest structure, local information can be used to justify the modification of functional habitat definitions.

Type A Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:
1. Canopy layers: The stand has two distinct tiers or is multi-layered with dominant conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.
2. Canopy Closure: The canopy closure of conifers greater than 120 ft. tall (or greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.
3. Large Trees: The density of conifers greater than 35 in. dbh averages more than nine stems per acre and not less than six stems per acre and includes a component of trees with sparse, broken, or dead tops.
4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre and not less than 8 stems per acre.
5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type B Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:
1. Canopy Layers: Moderately to strongly two-tiered or multi-layered with dominant conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.
2. Canopy Closure: The canopy closure of conifers greater than 100 ft. tall (or greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.
3. Large Trees: The density of conifers greater than 35 in. dbh averages more than six

stems per acre and not less than two stems per acre.

4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 25 stems per acre and not less than 20 stems per acre.

5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type C Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy Layers: Uniform to moderately layered with dominant conifers or hardwoods 50 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.

2. Canopy Closure: The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.

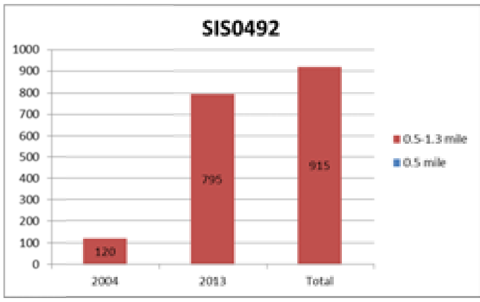
3. Large Trees: The density of conifers greater than 35 inches dbh averages less than six stems per acre and may be absent.

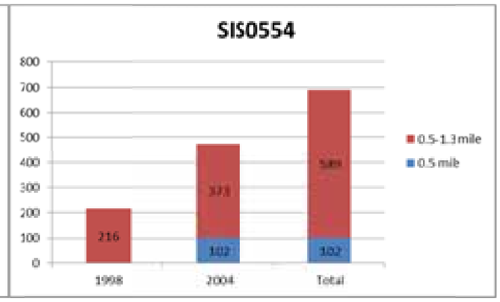
4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre, but may be absent.

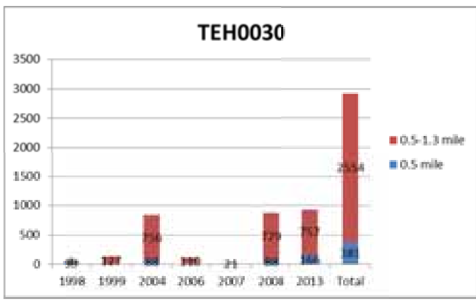
5. Small Trees: The density of conifers or hardwoods less than 18 inches dbh averages more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the stand, including small, medium, and large trees is greater than 10 inches.

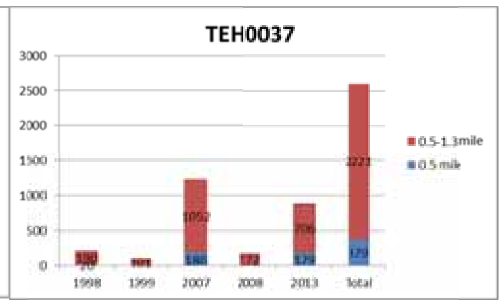
Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

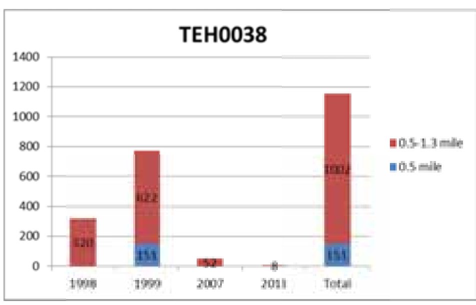
THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

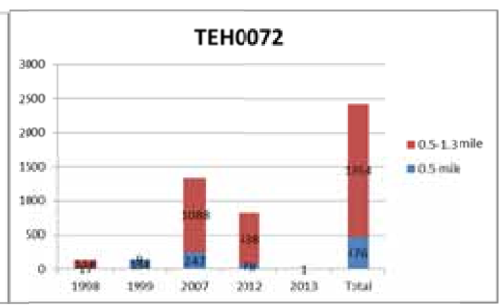












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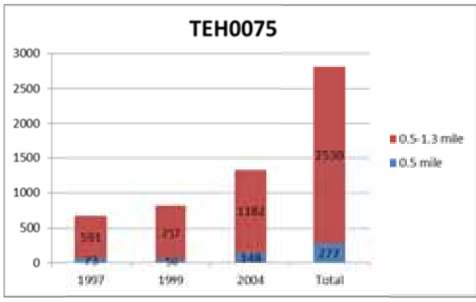

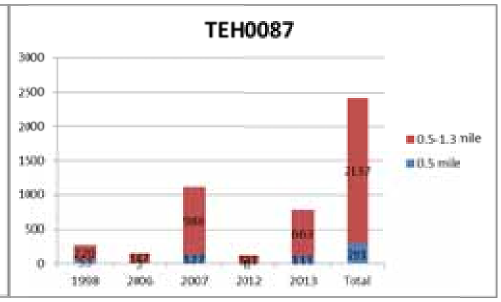

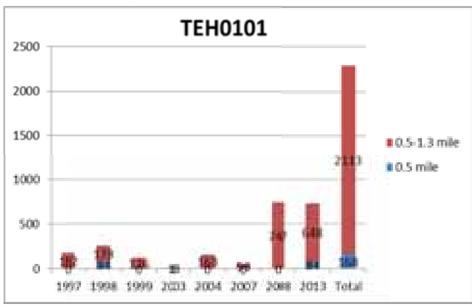

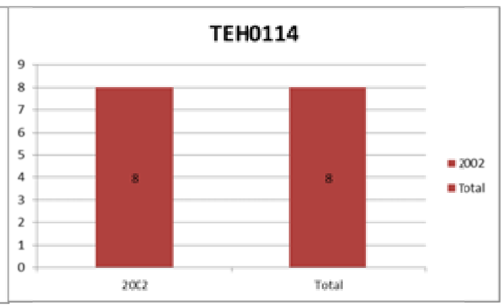

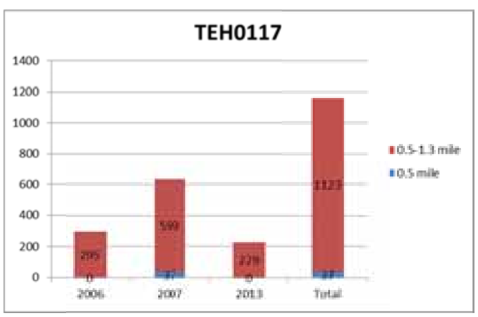

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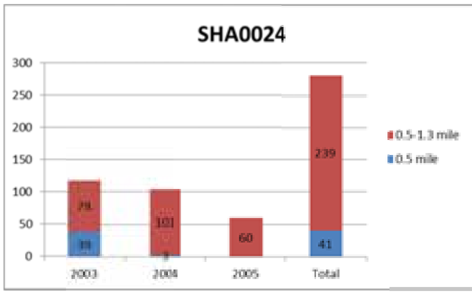
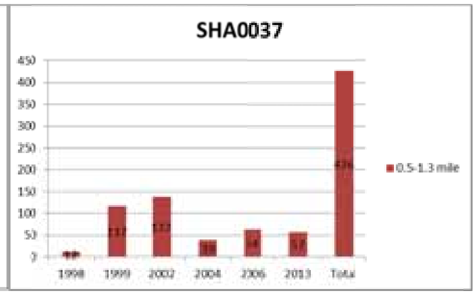
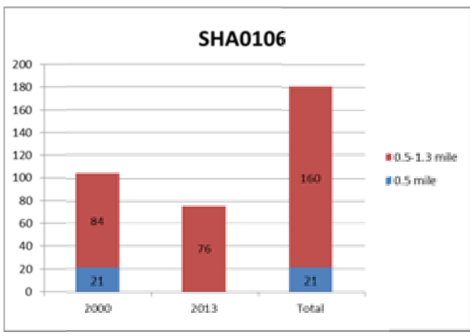
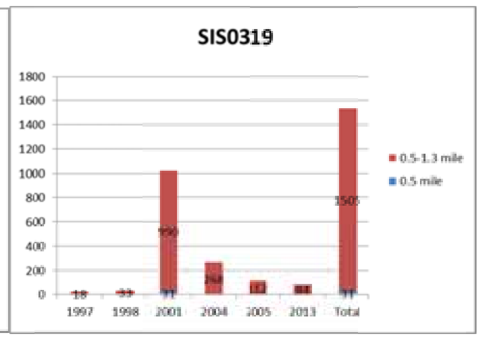
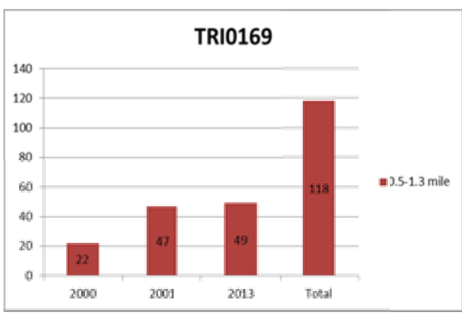
THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC

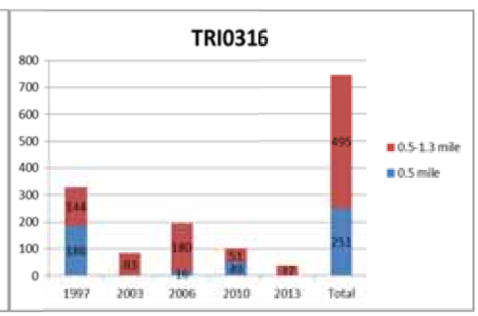




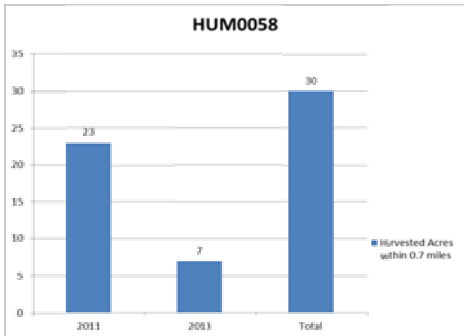


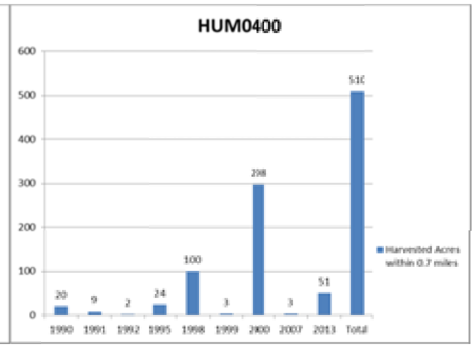


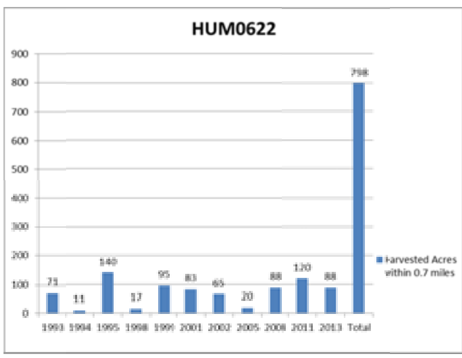


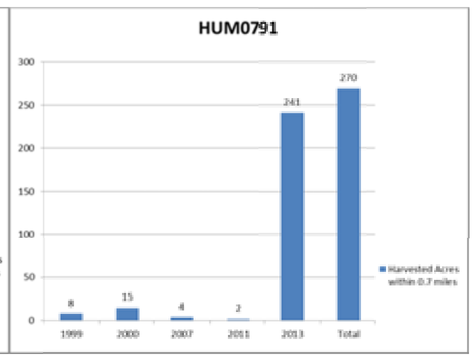


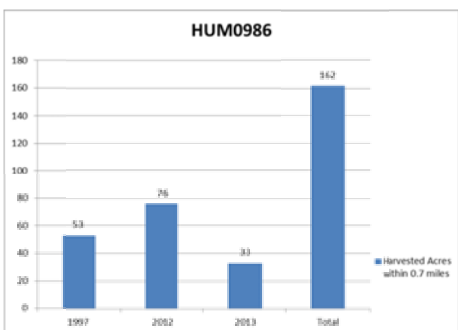
THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

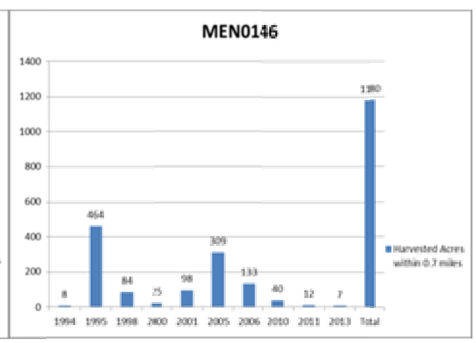












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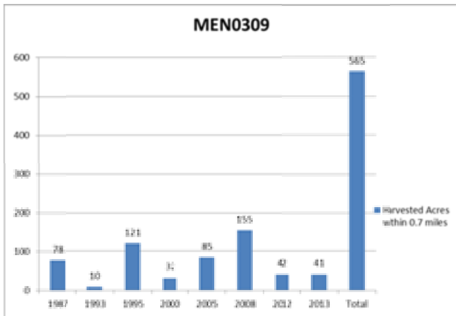

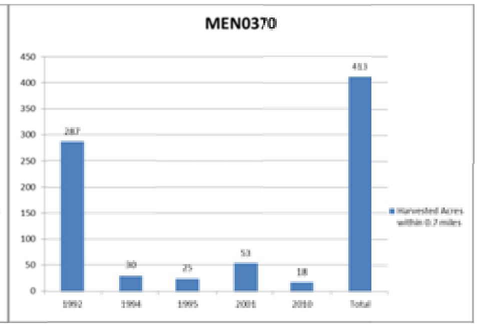

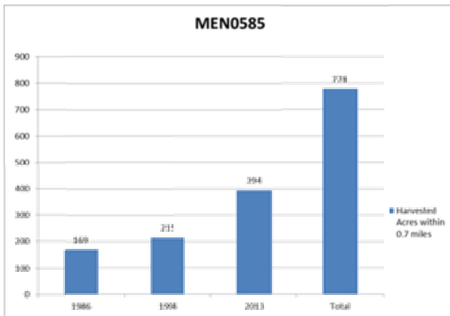

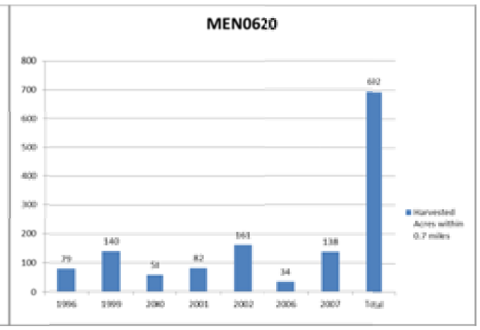

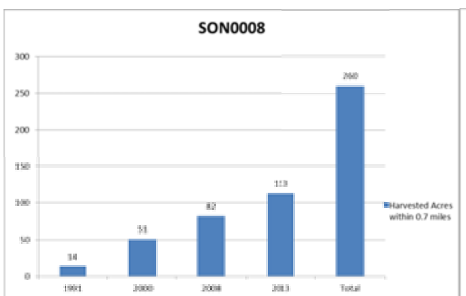

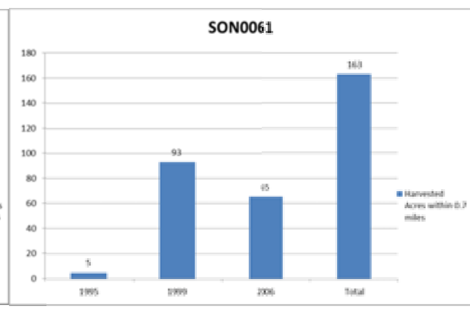

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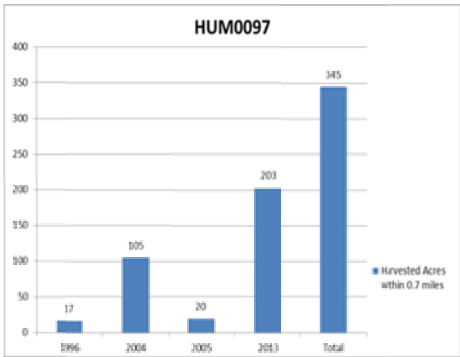
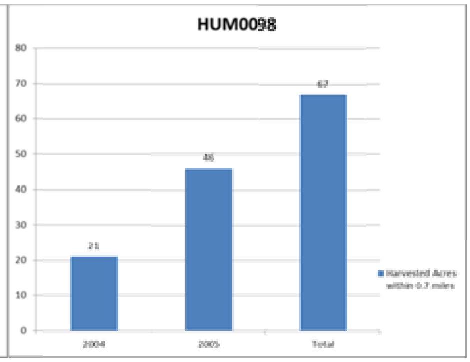
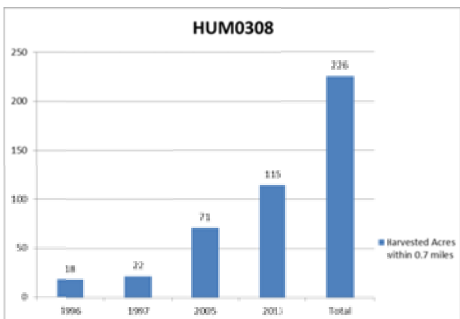
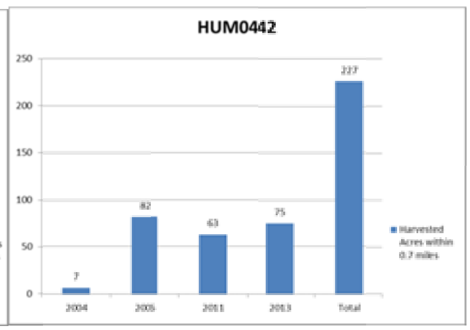
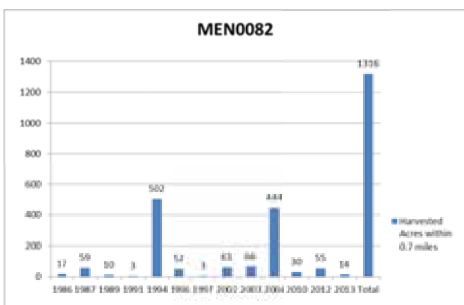
THP's utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

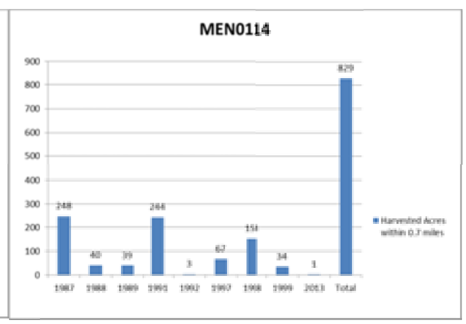












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Appendix 4. List of Acronyms and Abbreviations

AC	Activity Center
AMA	Adaptive Management Areas
AR	Anticoagulant Rodenticides
BLM	Bureau of Land Management
Board	Board of Forestry and Fire Protection
BO	Biological Opinion
BOE	Board of Equalization
BOF	State Board of Forestry and Fire Protection
CA State Parks	California Department of Parks and Recreation
CAL FIRE	California Department of Forestry and Fire Protection
Caltrans	California Department of Transportation
CBD	Center for Biological Diversity
CD	Consistency Determination
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CCAA	Candidate Conservation Agreement with Assurances
CDFW	California Department of Fish and Wildlife
CI	Confidence Interval
CNDDB	California Natural Diversity Database
Commission	Fish and Game Commission
CPV	Canine Parvovirus
CSA	Conservation Support Areas
CWHR	California Wildlife Habitat Relationships
DBH	Diameter at Breast Height
DSA	Density Study Area
Department	California Department of Fish and Wildlife
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
ESA	Federal Endangered Species Act
FEIS	Final Environmental Impact Statement
FRGP	Fisheries Restoration Grant Program
FGS	Fruit Growers Supply Company
FEMAT	Forest Ecosystem Management Assessment Team
FIA	Forest Inventory Analysis
FMP	Forest Management Plan
FPA	Forest Practice Act
FRI	Fire Return Interval
FSC	Forest Stewardship Council
GDR	Green Diamond Resource Company study area
GDRC	Green Diamond Resource Company
ITP	Incidental Take Permit
ITS	Incidental Take Statement
JDSF	Jackson Demonstration State Forest
HCP	Habitat Conservation Plan
HFP	Habitat Fitness Potential

HCVF	High Conservation Value Forests
HUP	Hoopa Indian Reservation study area
HRC	Humboldt Redwood Company
LSA	Late-Successional Areas
LSAA	Lake or Streambed Alteration Agreement
LSR	Late-Successional Reserve
MBF	1,000 board-foot
MIS	Management Indicator Species
MMCA	Marbled Murrelet Conservation Areas
MRC	Mendocino Redwood Company
NCA	National Conservation Area
NCCP	Natural Community Conservation Plan
NIPF	Non-industrial private forest
NPS	National Park Service
NSO	Northern Spotted Owl
NTMP	Nonindustrial Timber Management Plans
NTO	Notice of Operations
NWC	Northwest California study area
NWFP	Northwest Forest Plan
ORV	Off Road Vehicle
PCB	Private Consulting Biologists
PFT	Pacific Forest Trust
PL	Pacific Lumber Company
PRNS	Point Reyes National Seashore
PSU	Primary Sampling Unit
REF	Suppressed reproduction and growth
RNSP	Redwood National and State Parks
ROD	Record of Decision
RPF	Registered Professional Foresters
SEIS	Supplemental Environmental Impact Statement
SHA	Safe Harbor Agreement
SOMP	Spotted Owl Management Plans
SOP	Spotted Owl Expert
SORP	Spotted Owl Resource Plan
SFI	Sustainable Forestry Initiative
SP	State Park
SPI	Sierra Pacific Industries
TCP	Timberland Conservation Planning Program
THP	Timber Harvest Plan
TPZ	Timber Production Zone
UCNRS	UC Natural Reserve System
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USFS	United States Forest Service
WCSA	Willow Creek Study Area
WLPZ	Watercourse and Lake Protection Zones

WNV West Nile virus

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

Neil Clipperton
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Nongame Bird Conservation Coordinator
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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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Oregon Cooperative Fish & Wildlife Research Unit
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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 ~~over~~ 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) contain~~ed~~ most habitat types used by the owl, and 3) contain~~ed~~ 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).

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.

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 v~~V~~ital 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). ~~f~~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-analyses ~~demographic studies, which include three California study areas,~~ likely represent the best population demographic information on an endangered species ever assembled (Gutiérrez 2008).

Table 6. Descriptions of 11 demographic study areas used to assess vital rates and population trends 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

*Indicates the eight study areas that are part of the federal monitoring program for the Northern Spotted Owl.

~~The collection of an enormous amount of data over a long time period allows for estimation of vital rates across a large portion of the Northern Spotted Owl range. Data from the demographic study areas have been compiled and analyzed regularly, with the most recent analysis covering all survey years through 2013 (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016). The most recent analysis of the data (Dugger et al. 2016) is the 6th time data from these study areas were used to assess range-wide population status and trends of Northern Spotted Owl. Vital rates are evaluated on each individual study area and also using data from all study areas combined for a range-wide assessment of population status and trends (meta-analysis). Vital rates estimated include apparent survival, fecundity, recruitment, rate of population change, and site occupancy rates based on local extinction and colonization rates. Along with estimation of 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.~~

As discussed above, data collected from existing surveys are not sufficient to estimate population size, or density of Northern Spotted owls, ~~s, and~~ so trends in the absolute number of owls on each study areas over time cannot be assesses. ~~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~~ the annual rate of population change for territorial spotted owls (~~,~~i.e., lambda -

~~(~~λ), which reflects changes in population size from one year to the next due to ~~resulting from~~ annual reproduction, mortality, and movement into and out of a study area can be estimated from the data collected on these long-term demographic study areas (e.g., Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016). ~~Lambda does not provide a numerical estimate of population size, but instead estimates the rate of change in a population from one year to the next.~~

Decomposition of λ into apparent survival and recruitment allows for evaluation of the population parameters that may be influencing observed rates of population change (i.e. losses vs. gains to the population during each year). In this case apparent survival reflects both survival and emigration from the study area; recruitment represents the number of new animals entering the population including both *in situ* recruitment and immigration of recruits from outside the study area (Dugger et al. 2016). Modeling of adult apparent survival and fecundity is also conducted independently of λ on individual study areas to allow for estimation of these parameters ~~independent of immigration and~~ for investigation of covariates that influence these vital rates (i.e. factors that affect survival or reproduction of Northern Spotted Owls). Occupancy was modeled at the territory scale and provides an additional assessment of population status using data on presence or absence of owls at known sites. In sum, this thorough assessment of population parameters and factors that influence them provides a detailed evaluation of status and trends of Northern Spotted Owl populations, and provides important 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).

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.

The three Northern Spotted Owl demographic study areas located in California and included in the most recent meta-analysis represent 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 NWC and HUP study areas were characterized by mixtures of mature and old-growth forest interspersed with young forests regenerating on areas that had been clear-cut or burned. On the GDR study area, nearly all stands of old trees had been clear-cut and converted to young forests that were less than 70 years old (Dugger et al. 2016). In 2009, a Barred Owl removal study was implemented on the GDR study area by partitioning the study area into treatment (Barred Owls lethally removed) and control (Barred Owls undisturbed) areas (Diller et al. 2014, Dugger et al. 2016). The treatment and control areas were evaluated separately to estimate the response of Northern Spotted Owl vital rates to the removal activities. This study is discussed in detail in the Barred Owl threat section of this report, and is also referenced in this section as necessary.

Comment [DK4]: ?? – do you mean from the Critical Habitat document? You should include the specific source here.

~~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 (Dugger et al. 2016). 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).~~ 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~~R~~esults 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 ~~w~~here 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).

	Trends				**Estimates**	
Study Area[1]	**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 rate of decline). This annual rate corresponds to a population decline of 41% on the control area, although confidence limits for λ are large and broadly overlap 1.0 due to the small number of years in the post-treatment sample. The CAS study area in southern Oregon has experienced a population decline of 44% since 1994.

Annual rates of decline and the realized population changes continue to be highest in Washington and the COA study area of Oregon where Barred Owls have been well-established for a long time (Table 7). However, population declines are now occurring on study areas in California that were experiencing little decline or were stable through 2006, and the declines in California are accelerating (Dugger et al. 2016).

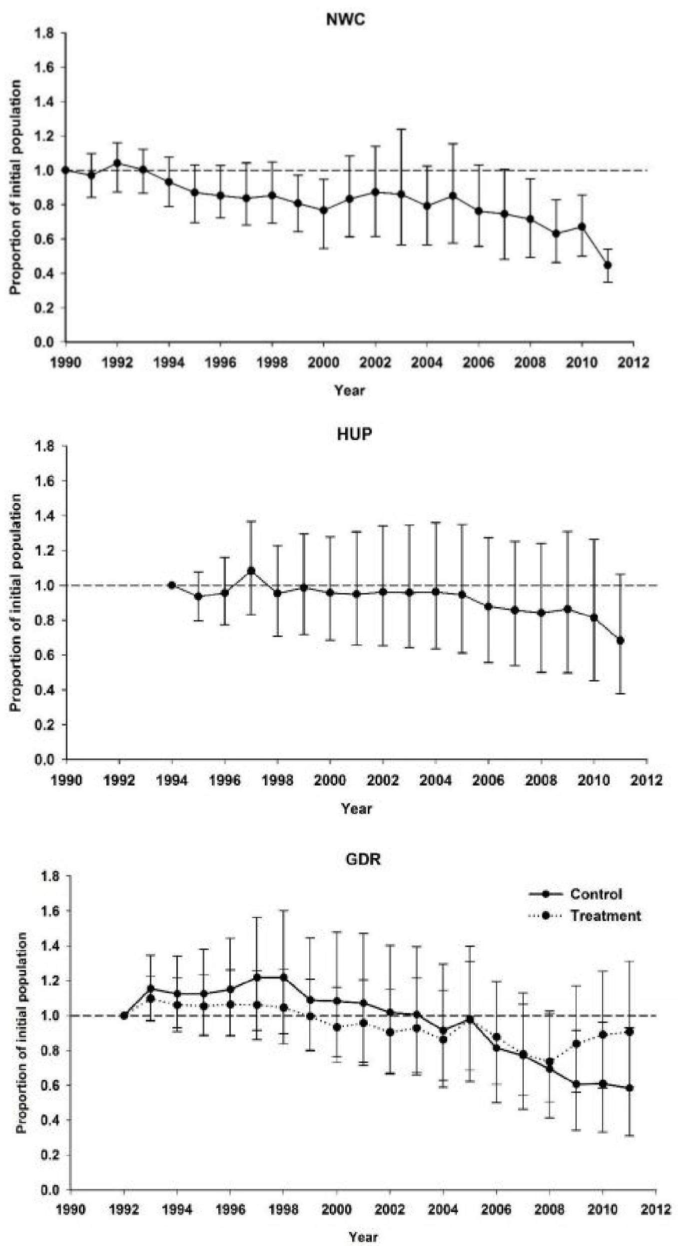

Figure X. Annual estimates of realized population change with 95% confidence intervals for Northern Spotted Owls at 3 study areas in California. Estimates for the GDR study area are presented separately for control and treatment areas in relation to Barred Owl removals beginning in 2009 (adapted from Figure 5 in Dugger et al. 2016).

Fecundity

Fecundity (i.e., number of female young produced per adult female) ~~-~~was estimated using 12,969 records of ~~in which~~ the number of young produced by each territorial female per year~~s was determined~~ (Dugger et al. 2016). Fecundity was influenced by the age of the female owl in all study areas, with mean fecundity generally lowest for 1-yr-olds, intermediate for 2-yr-olds, and highest for adults (Dugger et al. 2016). Mean annual fecundity of adult females ranged between 0.22 and 0.34 (number of female young produced per female per year) for most study areas with the HUP area in California having the lowest annual fecundity (excluding GDR Barred Owl control and treatment areas that have data for only the most recent five years) (Dugger et al. 2016). The Cle Elum study area in Washington was exceptional in that it has had a much higher fecundity rate than other areas (0.57). The range-wide mean annual adult fecundity was 0.31 for 1985-2013. This estimate of fecundity over a 29 year period was lower than any previously reported meta-analysis estimate for Northern Spotted Owls (Anderson and Burnham 1992, Burnham et al. 1994, Forsman et al. 1996, Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016).

Annual variation in fecundity is high for Northern Spotted Owls, due in part to the tendency to breed only every other year (Figure Y for California study areas). High annual variation can make ~~This may make i~~it ~~more~~ difficult to detect trends in fecundity relative ~~compared t~~to other vital rates that exhibit less temporal process variation (Dugger et al. 2016). Nevertheless, model results provide evidence for declining fecundity on all three study areas in California (Table 7; Dugger et al. 2016), with strong evidence of decline at the NWC study area. There was little support for strong habitat associations with fecundity on most study areas, however, more nesting and roosting habitat was associated with higher fecundity at the NWC study area and more habitat in the territory core was associated with higher fecundity at the GDR study area. Precipitation in the early nesting season was associated with a decline in fecundity at the HUP study area.

Annual r~~R~~eproductive rates have ~~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~~ 11 demographic study areas, so direct comparisons are not possible. Humboldt Redwood Company (HRC 2013) reported ~~noted~~ a decline ~~rop~~ in reproductive rates since 2009 (citation). 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. These low reproductive rates were reported ~~is is~~ despite weather conditions in 2013 that would typically support high ~~good~~ reproductive rates~~success~~. A similar results ~~This~~ was observed on many timber company lands (Calforests 2014, HRC 2014, GDRC 2015), tribal lands (Higley and Mendia 2013), the NWC study area (Franklin et al. 2015), National Park Service lands (Ellis et al. 2013), and on county-owned land in Marin County (Cormier 2013). During 2011, 2012 and 2013 HUP showed unusually low reproductive rates of 0.05, 0.13, and 0.06, chicks fledged per pair, respectively. The reason for this 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?

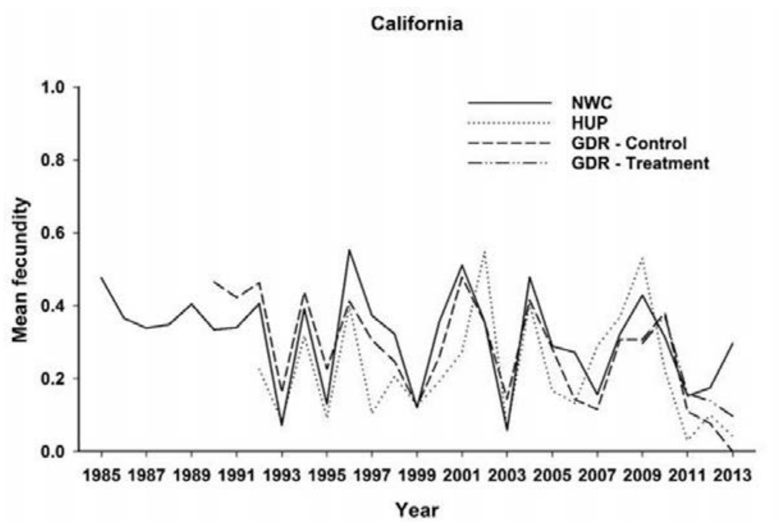

Figure Y. Annual fluctuations in mean fecundity (number of female young fledged per female) of Northern Spotted Owls in 3 study areas in California. Mean fecundity was graphed separately for the areas within the Green Diamond (GDR) study area where Barred Owls were removed (2009–2013; GDR-Treatment) 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~~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, t~~T~~he declines in occupancy rates have been accelerating at NWC and HUP (Figure Z), although ~~. O~~the occupancy rate ~~has~~ increased on ~~at~~ the GDR treatment area~~s~~ 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 ~~is~~ 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), t~~T~~he 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).

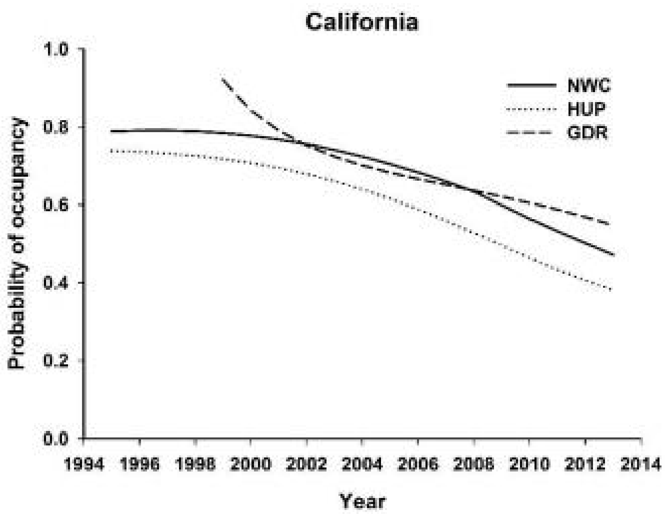

Figure Z. Estimates of the probability of territory occupancy for Northern Spotted Owls on three study areas in California (adapted from Figure 8 in Dugger et al. 2016).

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.

The estimated rates of fecundity and survival are per capita averages across 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. Information on rates of survival and fecundity provide a clearer picture of potential mechanisms for population declines (i.e., determination of vital rates that are contributing most to the population declines and factors influencing those rates), but must be considered in association with the number of territorial owls and the factors that drive occupancy rate in order to understand the broader impact to a population.

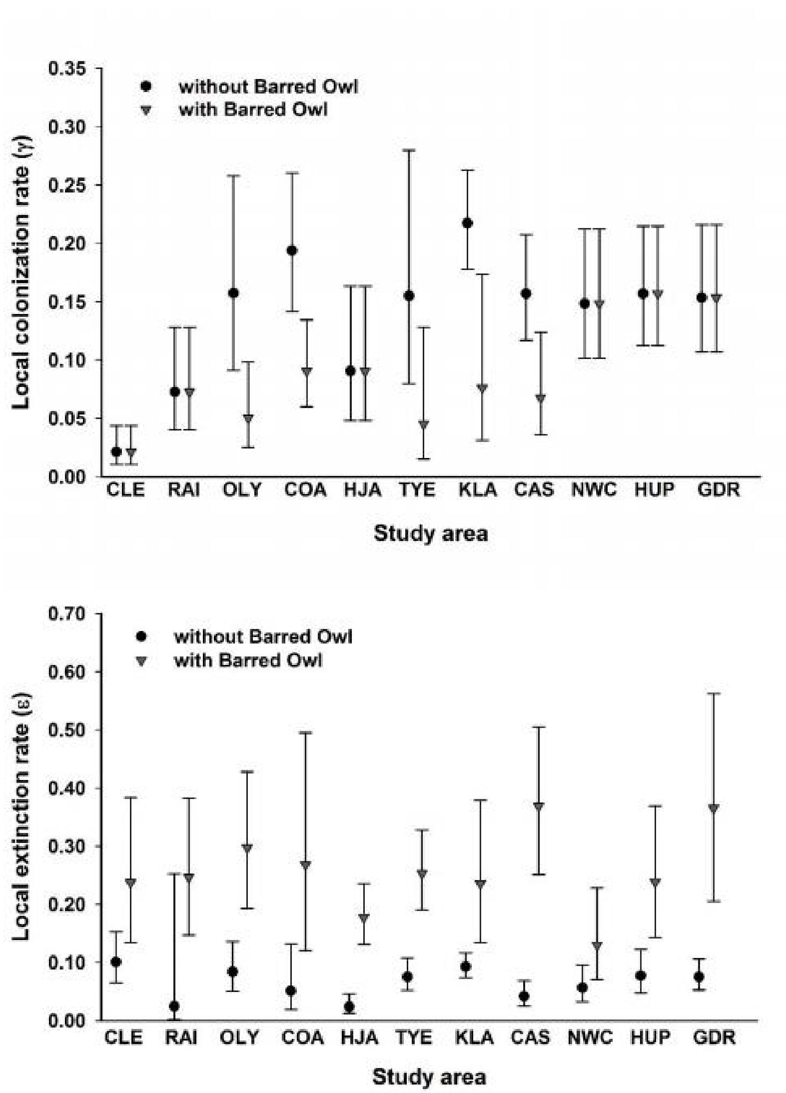

Figure XX. Mean local colonization and extinction rates with 95% confidence limits for Northern Spotted Owls on 11 study areas in Washington, Oregon, and California when Barred Owls are present (gray triangles) or absent (black circles) (adapted from Figure 7 in Dugger et al. 2016).

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.

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 (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).

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.

Although occupancy will often reflect changes in local population size and can provide an alternative to the estimated rate of population change in assessing population status, it is not always appropriate to use an apparently stable occupancy rate to suggest a stable population size. Forsman et al. (1996) makes the following statement regarding occupancy and population declines:

> "…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 over the short-term might not reflect vital rates in the local population. 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 t~~The annual rate of population decline (λ) will actually increase ~~, the phenomenon should gradually disappear~~ as the floater population is depleted, because recruitment must then come entirely from continued, annual production of young. If a study area has a relatively robust population of floaters, or if emigration into the study area occurs, the total local population can decline for some time before ~~being detected through~~ declines in territory occupancy are observed. 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 local population is stable, so estimates of survival and fecundity are also important for assessing the overall status of a population.

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 presence-absence data from 1995-2009 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 for both any detected owl (single or a pair) and pairs, declined approximately 40% over the 15 year period (Farber and Kroll 2012). ~~; s~~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). These results from private timberlands are consistent with the declines observed on federal lands to the north at the CAS study area in southern Oregon (Dugger et al. 2016). Although estimates of occupancy rate are not available, Northern Spotted Owls appear to have been nearly extirpated from the 97,000 acre Redwood National and State Parks on the northern

California coast in Del Norte and Humboldt counties. Forty Northern Spotted Owl activity centers were identified in the parks during the 1990s but most of these sites appear to ~~are~~ now be occupied by Barred Owls only (Schmidt 2013). Only four Northern Spotted Owls were detected in these National P~~p~~arks during 2013-2014, with only one pair observed; the last Northern Spotted Owl fledgling ~~juvenile~~ known to have been produced in the parks was reported in 2010 (Schmidt 2015). At the extreme southern edge of the Northern Spotted Owl range in Marin County, recent surveys of 30 historical Spotted Owl sites using the USFWS protocol have shown that naïve estimates of pair occupancy remained high at about 90% (Cormier 2013). Interestingly, t~~T~~his is a portion of the range where Barred Owls remain relatively uncommon.

The Department evaluated occupancy data and results provided by nine private timber management companies (Calforests 2014). In contrast to the above studies at demographic study areas and at other well-monitored areas that showed modeled declines in occupancy or displacement of Northern Spotted Owls, five of nine companies 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, the method used to estimate occupancy rate, or the portion of the owl population assessed (Calforests 2014). However, several issues with the survey methods or analyses are apparent. In at least two cases the samples appear biased due to surveying only the best sites every year or excluding sites where Barred Owl had been detected. In several cases survey methods varied from site to site, or from year to year. 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 (citations?). Counts of occupied sites and detection probability are both dependent on survey effort and survey effort was not always reported. An example of this can be seen in data submitted by Mendocino Redwood Company, which shows a positive correlation between survey effort and estimates of occupancy (citations?). In several cases, the level of detail at which methods are described does not allow for evaluation of occupancy estimates.

The variability in survey methods used, reports of counts or naïve estimates of occupancy without consideration of detection probability, the sometimes inconsistent or biased methods used over time, and the limited description of methods results in little support for the conclusion by ~~from~~ some timber companies that occupancy rates have been stable over time.

However, t~~T~~hree timber companies reported results of occupancy modeling that incorporated estimates of detection probability. Of these, the Green Diamond Resource Company has participated in the large demographic study since 1990 and the large declines in occupancy at the study area are reported above. The Mendocino Redwood Company reported a slight decline in occupancy rates based on modeling of data collected for a subset of years from 2001-2008, but no estimate of occupancy rate was presented for more recent years during which the local Barred Owl population has increased dramatically (MRC 2014). Campbell Global, L.L.C. manages timber lands for multiple owners, and reported on occupancy rates for two ownerships in Mendocino County (Calforests 2014). Occupancy dynamics were modeled using data from 1990-2010 for these Mendocino County ownerships and ~~;~~ occupancy probabilities for single Northern Spotted Owls began to decline in 2003, while ~~and~~ pair occupancy rates declined by 16-30% during the initial portion of the time period before stabilizing in 1997. In each of these cases the

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?

Comment [DK15]: Is this all from "calforests 2014?)

Comment [DK16]: Isn't this site one of the few with almost no BO? At least until very recently?

results of occupancy modeling demonstrated evidence of declining occupancy rates, providing 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 change~~s~~, 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 haves 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

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: 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

Cover photograph © Robert Hawkins, used with permission.

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, section2074.6, 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.

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.

> 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, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.

> 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 such migratory nongame bird except as provided by rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory Treaty Act.

California Board of Forestry and Fire Protection

The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire Protection (CAL FIRE) have designated Northern Spotted Owl as a “Sensitive Species” as identified in the California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules). These sections also define Northern Spotted Owl -related terminology, including “activity center”, “Northern Spotted Owl breeding season”, and “Northern Spotted Owl Evaluation Area.” Specific requirements for the disclosure of information on Northern Spotted 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 sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and related activities, would be avoided according to the criteria for determining take avoidance found in Section 919.10. Other 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 nests through buffers and avoidance of sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the protections afforded to late successional forests, which are a component of Northern Spotted Owl habitat.

International Union for Conservation of Nature

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

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

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 km^2 (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

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 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/km^2) 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/ km^2 of habitat) at 0.544 owls/km^2 (95% CI = 0.495-0.592) and 0.660 owls/km^2 (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km^2. 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/km^2±0.006, 0.351 owls/km2±0.011, and 0.313 owls/km^2±0.017 for Klamath, Korbel and Mad River regions respectively, with an overall mean density of 0.209 owls/km^2±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbel, 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/km^2 in the northern portion of their land in Humboldt County, and 0.78 owls/km^2 in southern portions. Sierra Pacific Industry reported 0.450 owls/km^2 between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km^2 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/km^2 of area surveyed (MRC 2014). Lastly, Humboldt

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

Comment [ABF8]: See my General Comment 1 for the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

Comment [ABF9]: GDRC 2015 reported these as owls/1000 acres and not owls/km^2. These estimates should be reported as 0.042 and 0.192 owls/km^2, 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

Redwood Company (HRC) reported 1.22 occupied territories/km^2 and 2.23 owls/km^2 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.

Comment [ABF11]: See my General Comment # 1 for changes that need to be made on the valueas and format of this table

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.

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.

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

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.

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 m^2/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 Kernal, and Adaptive Kernal) 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 forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference between breeding and nonbreeding seasons. The study showed core area size, annual home range and breeding home range size increased as amount of hard edge increased (Schilling et al. 2013). In their study site 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, with ranges being 3.5 times larger during the fall and winter months.

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, 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 (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 (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). Forsman et al. (2015) attributes the larger winter home range to prey dynamics and exploratory excursions in search of better habitat.

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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 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

Dispersal

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

In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent 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 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). While the only data available on dispersal pertains to Northern Spotted Owls in Washington and Oregon, and California Spotted Owls in California, we can extrapolate that Northern Spotted Owls in California act similarly, because, while the populations are genetically and geographically distinct, they still share many 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. Guti,rrez 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.

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

Habitat Requirements

Comment [ABF21]: See my General Comment #4 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al. 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 (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. 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 Gutiérrez1990 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 Gutiérrez1999, Swindle et al. 1999, Weathers et al. 2001, Courtney et al. 2004, USFWS 2008a, USFWS 2011a).

Comment [ABF22]: Also reference Blakesley et al. 1992

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."

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 with~~and~~ variable timber management practices (Thomas et al. 1990, Thome et al. 1999, USFWS 2011a, Irwin et al. 2013).

Comment [ABF23]: Incomplete sentence

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 (tress >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).

Comment [ABF24]: See also Ward et al. 1998

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 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry

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 (Gutiérrez1996, 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 diameter[1] 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 m^2/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.

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 ~~W~~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 replae 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) 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.

<u>California Coast Province</u>

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

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.

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

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

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

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 DBH[1] >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 QMD[2] >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

			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	nesting-roosting habitat: for most locations average DBH >17 inches and average conifer canopy cover >60%; foraging habitat: 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 ans elsewhere (see my General Comment 3 under the THREATS section)

California Cascade Province

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

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

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

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

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

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

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

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

Habitat Effects on Survival and Reproduction

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

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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).

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

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.

Comment [ABF39]: Need to be careful here because Bart & Forsman also used 20-690 km^2 compartments containing multiple territories, which were not territory-based but based on groups of territories.

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 change[2]) 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

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

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.

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.

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.

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.

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 ≥40%, and overstory canopy coverage of ≥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).

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

Comment [ABF42]: See my General Comment 4 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section

	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%	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** 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**	**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

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

[a]Size 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.

[b]Size 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.

[c]Franklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types.

[d]Edge 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.

[e]Franklin 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

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).

Comment [ABF44]: Nee to use consistent terminology throughout this subsection. Productivity in Olson et al. 2005 was synonymous with reproductive output in Franklin et al 2000.

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 m^2/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.

Comment [ABF45]: Aslo 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.

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.

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.

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 [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 I less problematic if inferences are to territorial owls (as opposed to territorial owls + floaters)

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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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, 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.

Comment [ABF51]: Another point is that territories are also dynamic across the landscape as forests age.

Comment [ABF52]: Incomplete sentence

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.

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.

Comment [ABF55]: But the Southern Cascades study area is just across the border in OR; should probably note that.

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**
Washington				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
Oregon				
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
California				
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.

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.

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.

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)

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 [ABF60]: The meta-analysis actually took place in 2009 and was not published until 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 lambda (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.

Comment [ABF61]: You need to be careful about making these comparisons (see my General Comment 3 under the STATUS AND TRENDS IN CALIFORNIA section).

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]
Washington				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
Oregon				
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
California				
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.

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).

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.

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).

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.

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.

Comment [ABF66]: See my General Comment 5 under the STATUS AND TRENDS IN CALIFORNIA section

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. 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 a~~e~~ffected 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

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

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.

Comment [ABF72]: But keep in mind that all of these different metrics are highly correlated (i.e., fecundity ≈ 1/2 number of young fledged/site

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.

Comment [ABF73]: Franklin et al. 2015 also reported low reproduction for 2011 and 2012 (see their Table 6)

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

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

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.

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 [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.

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."

Comment [ABF77]: This violates the closure assumption of occupancy estimation. It could be resolved if movement is better understood (e.g., does it occur later in the season?) and accounted for in sampling.

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).

Comment [ABF78]: This sentence did not make sense. Mortality and detection are two independent events (dead owls obviously cannot be detected during surveys).

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 [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.

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).

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. 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.

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.

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).

In contrast to the above studies at demographic study areas and at other well-monitored areas that showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the 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.

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?

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 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.

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.

Source-Sink Dynamics

Comment [ABF84]: See my General Comment 1 under the STATUS AND TRENDS IN CALIFORNIA section

Pulliam (1988) was the landmark publication on source-sink population dynamics. Since then, 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 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
Modeling Regions			
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
Physiographic Provinces			
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

to the California Coast Range, California Cascades and Oregon Klamath provinces, with net flux most notable to the California Coast Range province.

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

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
Modeling Regions			
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
Physiographic Provinces			
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

Schumaker et al. (2014) results suggest that California's population of Northern Spotted Owls is a significant component of and source to the range-wide population. As a source, the Klamath region populations provide a source of owls to sink populations on the Coast and Cascade ranges. This concept is central to protection of owl habitat, especially dispersal habitat, for the continued persistence of Northern Spotted Owls across their range.

Existing Management

Land Ownership Patterns in Northern Spotted Owl Range

The laws and regulations governing management of forests in the range of the Northern Spotted Owl vary depending on ownership. For this reason, the following discussion on existing management is partitioned based on ownership, with lands governed by a common set of regulations. In general, federal timberlands in the range of the Northern Spotted Owl are governed by the NWFP, with some 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 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 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)
Total	*24,465,790 (100)*

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.

However, silviculture treatments (including thinning in stands less than 80 years old west of the Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district plans as being withdrawn from timber production and include recreational and visual areas, back country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with smaller amounts of reserved lands on the coast (Figure 11).

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

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

<u>Late Successional Reserves:</u>

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

- 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:
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., 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

- Retention of large snags and down logs within thinning units
- Retention of hardwoods
- 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-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 develop more natural stand characteristics in areas that were previously harvested, improve watershed and fisheries health, and protection from wildfire risk. Some of these previously-logged areas have burned in high intensity fires, or are at risk for future fires of stand-replacing intensity. The primary goal in silvicultural treatments is to increase the Douglas-fir component in tanoak dominated stands, and "fireproof" this Douglas-fir component so that it has a greater chance to reach maturity.

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

National Park Service

Redwood National and State Parks

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

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

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

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

In 1978, Congress expanded RNSP to include 38,000 acres that had been logged between 1950 and 1978 using clearcut tractor logging. With the expansion of the RNSP, commercial operations including active forest management and silviculture thinning ceased which resulted in second-growth forest conditions “considered unhealthy from both a silviculture and an ecological standpoint” (NPS 2008, NPS 2009a).

Many of the second-growth forest stands were primarily high-density, even-aged Douglas-fir stands with little canopy structure and no understory development. The focus of second-growth forest restoration is to reduce stand density (thinning) to promote growth of remaining trees while protecting adjacent old-growth forests, as well as maintaining water quality in riparian habitats, minimizing tanoak tree disturbance, and minimizing excessive fuel build-up on the forest floor.

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

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

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

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

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

<u>Point Reyes National Seashore and Muir Woods National Monument</u>

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

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

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

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

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

- Treatment activities or any noise generation above ambient noise levels will not occur within 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as surveys conforming to accepted protocol have determined that the site is unoccupied or non-nesting or nest failure is confirmed.
- Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially alter the percent cover of canopy overstory and will preserve multilayered structure. When shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency vehicle clearance.
- Prior to fire management activities, project areas will be surveyed for the presence of dusky footed woodrat nests. If feasible, woodrat nests will be protected.

- Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a determination is made that the native tree presents a clear hazard in the event of a fire or cutting is the only option to reduce high fuel loading.
- The fire management officer will arrange for qualified biologists to conduct post-project monitoring to determine short- and long-term effects of fire management actions on activity centers if resources are available.

Tribal Lands

Hoopa Valley Indian Reservation

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

The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late successional reserves to the north, south, and east, and Redwood National Park to the northwest. The reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40 pairs of owls at all times during the planning period. However, the plan notes this number of Northern Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

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

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

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

Yurok Indian Reservation

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

The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for intensive surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites. The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on disturbance activities within 0.25 mile of Northern Spotted Owl nest.

Round Valley Indian Reservation

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

Nonfederal Land

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

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

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

A Timber Harvesting Plan (THP) is generally the environmental review document submitted by landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment. THPs are prepared by Registered Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These biologists would become the first "designated biologists" who would consult on proposed THPs.

Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules and procedures that would be adopted in the event of listing. The rules identified descriptions of Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for timber operations to avoid take. The rules called for consultations between plan proponents and Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to amend the initially adopted emergency rules; amendments to the rules occurred several times as knowledge of the Northern Spotted Owl increased and with experience gained through implementation of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] in March 1991, 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.

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

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

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

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

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

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

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

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

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

Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol, breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol was revised (USFWS 2012).

When consultations with the USFWS were required, they consisted of a field review of the proposed THP area, an evaluation of the pre-harvest and predicted post-harvest habitat typing (its suitability for nesting, roosting, or foraging), the sufficiency of habitat retained post-harvest within 500 feet, 0.7 mile and 1.3 mile of owl ACs, and an evaluation of the adequacy of the surveys that were conducted (i.e.

timing, location, interpretation of results) and their consistency with the USFWS protocol. When appropriate, the Department designated biologists would evaluate or propose THP-specific habitat and temporal buffers that differed from standard Forest Practice Rules habitat retention and seasonal restriction requirements that would be adopted as enforceable conditions of THPs.

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

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

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

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

- Other emerging and compelling forestry sector conservation issues required Department staff's attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related workload).
- The Department "Timber Harvest Assessment Program" (later to become the "Timberland Conservation Planning Program") budget did not include funding specifically for consultations.
- Staffing of USFWS offices with wildlife biologists had increased.
- The Department felt CAL FIRE and USFWS staff were capable of review, approval, and assessment of THPs and NTMPs.
- The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- The scope, quality and conformance of owl-related information with Forest Practice Rules requirements appeared to have stabilized after approximately six years of implementation.

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

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

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

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

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

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.

13 THPs from Interior Counties	Acres	62 THPs from Coastal Counties	Acres
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

habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat from Forest Practice Rules guidelines.

Forest Practice Rules guidelines under Option (g) are:

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

The USFWS (2009) recommendations are:

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

As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option (e) 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 six interior THPs, four primary habitat types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-habitat.

Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior, and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within 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; 47,344 acres of nesting and roosting).

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).

	6 Interior THPs associated with 14 activity centers, Option (e)		60 Coastal THPs associated with 132 activity centers, Option (e)
	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

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).

	7 Interior THPs associated with 8 activity centers, Option (g)		2 Coastal THPs associated with 6 activity centers, Option (g)
	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

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.), 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.

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.

		Interior, Option (e) Acres harvested		**Interior, Option (g) Acres harvested**	
Activity Center	**Range of Harvest Years**	**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

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

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

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

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

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.

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

Table 17. Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years 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
Interior Counties 1991-2014					
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
Coastal Counties 2005-2014					
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**

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

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
Interior Counties 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
Coastal Counties 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**

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

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?

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

The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear that some information was not available to the reviewer due to the nature of the older NTMP narratives, limited public information, and subsequent amendment submissions. There is simply no effective way to track this information in an analysis going back in time. Though Selection and Group Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range, we can infer that owl habitat is retained to some extent; however, we could not 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.

Spotted Owl Management Plans

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

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

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

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

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

<u>Spotted Owl Resource Plans</u>

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

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

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

<u>Habitat Conservation Plans</u>

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

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/mi^2 and 0.32 owls/mi^2, 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

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

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

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

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

According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the

understanding of suitable owl habitat was limited. In 2006, GDRC submitted an application to the USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes the Project, requires the Applicant to comply with terms of the amended BO and its associated incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified the Department that the BO was issued and requested that the Department issue a consistency determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1. In January 2014, the Department found that BO, 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-Iisted species (CDFW 2014a).

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

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

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 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.

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

Northern Spotted Owl management objective outlined in the plan include:

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.

Northern Spotted Owl conservation measures outlined in the plan include:

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.
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.
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 31site 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.
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.

Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable owl habitat must be provided, if present, and less than 50 percent of this shall be under operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided, within 1.3 miles of each activity center.

5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of each year to make up the minimum number of activity centers designated by the HCP. “Level Two” habitat retention must 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. Following the breeding season, 18 acres around the AC shall be maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC must the in place. For sites, which have been determined to be occupied by a non-nesting pair or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and a 400 foot radius buffer protecting the activity center must the in place. Harvesting of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat retention area.

6. Activity center that are not needed to meet management objectives above shall receive “Level Three” protection measures. These activity centers shall have a 1,000-foot buffer during the breeding season. Timber harvest associated may occur before March 1 or after August 31. During the breeding season, for activity centers which have been determined to be occupied by a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur during the breeding season in the area adjoining the 18-acre habitat retention area.

7. All nest trees shall be marked and be retained if the activity center is harvested.

The HCP outlines an objective to conserve habitat diversity and structural components within the plan area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types and seral stages are maintained across the landscape over the permit period, as well as structural components, to contribute to the maintenance of wildlife species covered under the plan, including the Northern Spotted Owl.

Structural components to be retained include:

1. A certain number and size snags that do not pose a human safety hazard.

2. A certain number and size of green replacement trees, if snags are not present, with a priority for trees other than redwood.

3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or cavities.

4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a maximum of two per acre.

5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given to logs over 30 inches in diameter.

In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in fact 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 2014b).

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

- Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and federal governments to ensure their functions as wildlife reserves in perpetuity.
- Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting habitat in a series of Marbled Murrelet Conservation Areas (MMCAs).
- Conduct a combination of night and daytime surveys and stand searches to locate both known, and any new, owl activity centers.
- Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other conservation elements of the HCP for the retention and recruitment of potential foraging, roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
- Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 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.
- Conduct complete annual censuses to monitor all activity centers on the ownership and to determine numbers of pairs, nesting pairs, and reproductive rates.
- Survey the THP area and a 1,000-foot buffer for new operations, except site preparation, initiated in the period beginning February 21 and ending on or before August 31.
- Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and detection probabilities using accumulated survey data.
- Submit annual reports describing the activities undertaken, results of the Operating Conservation Program, and the proposed Operating Conservation Program activities for the next year for all lands covered by the HCP.

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: September 8, 2015

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

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

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

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

Terra Springs LLC HCP

The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa County west of the city of St. Helena, and is located within the California Coast Province. The plan has a 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting, roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees, felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices, retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous

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

federal and private lands have shown that many activity centers are located on or have a home range that extends onto the FGS ownership.

Safe Harbor Agreements

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

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

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

Forster-Gill, Inc., Safe Harbor Agreement

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

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

- Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
- Retain all snags not posing a hazard risk.
- Conduct annual owl surveys on property and within a 500 foot radius around the property.
- Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
- Ensure no harvest occurs within 1,000 ft of any active owls nest site.
- Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and approved by USFWS.
- Conduct timber stand inventories and provide USFWS with data.
- Allow USFWS or other agreed-upon party access to property for monitoring and management activities.

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.

<u>Exemption Harvest</u>

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

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

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

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

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

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

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

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

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

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

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

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

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

The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet from any point of an habitable structure that complies with California Building Code for the purpose of reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2, 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project area shall be increased in the post-harvest stand.

During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS, approximately 41,767,250 acres (1992 to 2013) have been exempted for harvest in counties within the

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.

<u>Emergency Harvest</u>

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.

- Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood, landslide, or earthquake.
- Dead or dying trees as a result of air or water pollution.
- Cutting or removing trees required for emergency construction or repair of roads.
- Cutting and removal of hazardous fuels.
- Treatments to eradicate an infestation of Sudden Oak Death.

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

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

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

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

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

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.

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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Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak woodlands and prairies is managed through tree removal and burning. Nine management zones within the RNSP delineate the degree of human influence and development on that can occur on the landscape (NPS 2000a).

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

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

University of California Natural Reserves

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

Department Ecological Reserves

Authorized by the California Legislature in 1968 and administered by the Department, the ecological reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats, and to provide areas for education and scientific research. The system now encompasses 119 properties totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur within the range of the Northern Spotted Owl; however there are no management plans for the system or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by BLM, which manages for late seral habitat benefiting Spotted Owls.

Fisheries Restoration Grant Program

As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern Spotted Owls and their habitat are required for each project funded. The purpose of FGRP is to support restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must

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

large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat (see Figure 4).

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

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 Forst Plan"

The Northern Spotted Owl was listed under the federal Endangered Species Act in 1990 in part because of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls, ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or degradation from stand replacing wildfire and other disturbances, and loss of amount and distribution of Spotted Owl habitat as a result of past activities and disturbances (USFWS 2011a). To address ongoing decline of Northern Spotted Owl habitat across the range, the NWFP established reserved lands including late-seral reserves, adaptive management reserves, congressionally reserved lands, managed late-successional areas, and larger blocks of administratively withdrawn lands (USDA and USDI 1994) (Figure 11). These are described in more detail above. It was assumed that habitat in reserves would improve over time as successional processes led to more mature forests, however, this is a slow process and so recruitment of habitat conditions on reserves was expected to take many decades. It was also assumed that habitat outside of reserves would continue to decline due to timber harvest and other disturbances but that dispersal habitat would be maintained in order to facilitate movement between reserve lands. Given the continued Northern Spotted Owl population declines and the increasing threat of the Barred Owl, the revised recovery plan recommended conserving occupied sites and unoccupied, high-value Spotted Owl habitat on state and private lands wherever possible (USFWS 2011a).

In order to understand the degree to which the NWFP contributes to conservation of owl habitat, the rangewide trends in habitat are regularly assessed. To date, assessments have been performed at the 10-year and 15-year time points (Davis and Lint 2005, Davis et al. 2011). The recent assessment estimated rangewide habitat changes on federal and nonfederal lands from 1994 through 2007 for California and from 1996 through 2006 in Oregon and Washington by comparing vegetation maps for two bookend time periods. In addition to rangewide changes, trends for each physiographic province and for each state are also reported (Davis et al. 2011). The assessment tracks changes in Northern Spotted Owl nesting and roosting habitat, and also tracks changes in dispersal habitat within and

between the reserves. Foraging habitat is not assessed through modeling for the NWFP. Nesting and roosting habitat maps were produced through habitat suitability modeling using several forest structure variables (e.g., percent conifer cover, average conifer dbh, average stand height) and a forest age variable (Davis et al. 2011). Vegetation stands were placed in one of four categories (highly suitable, suitable, marginal, and unsuitable), with highly suitable and suitable categories assumed to represent nesting and roosting habitat (Davis et al. 2011). To assess change, an area was considered to have lost nesting and roosting habitat if its condition moved from suitable or highly suitable to marginal or unsuitable.

Although federal lands contain less than half of the total forest land within the entire range of the Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on nonreserved lands.

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

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

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

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

Comment [ABF89]: See my General Comment 1 under the THREATS section.

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).

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.

Timber Harvest

Timber Harvest on Private Land

Comment [ABF91]: A lot of this section seems to be a repeat from the Existing Management section.

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 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

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 utilizing 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 the level of information available, particularly older plans, was limited in some cases. Considering 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 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

Comment [ABF92]: See my General Comment 3 under the THREATS section

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 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), 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

Comment [ABF93]: Much of these mature forest include both conifer and hardwood species 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, Bignham 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 varies from 30-60%, with an average of about 45% (USFWS 2009). For a more detailed discussion on core and home range use, see Biology and Ecology section of this report.

As discussed in the Habitat Requirements section of this report, 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; Franklin et al. 2000). See the Habitat Effects on Survival and Reproduction section of this report for a discussion of HFP and additional studies that have contributed to an understanding of habitat characteristics that provide high HFP. The studies that have evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

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

The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory loss. They found on private timber lands there was a 54% decline in pair status to no response, and a 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change pair status. A lack of owl responses and a lack of suitable habitat to support continued occupancy and survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat 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) 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.

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).

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			

[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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Table 22. 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 interior region of 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.

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 form 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

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

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 mi^2) 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

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.

Wildfire

Effect of Wildfire and Salvage Logging

Comment [ABF95]: See my General Comment 4 under the THREATS section

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, 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; much uncertainty remains on the effect of wildfires on the extent and quality of Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates by Spotted Owls have 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 and from southwestern Oregon in the range of the Northern Spotted Owl, 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 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 ≥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).

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

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

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

<u>Historical Fire Regime in the Cascades Province</u>

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 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 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 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 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).

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

Several studies have determined a strong link between changes in fire extent, severity and season, with low precipitation and high temperatures. In addition to land-use history over the last century, climate 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.

<u>Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat</u>

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 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).

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).

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 that 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. McIntrye 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. 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 120,000km^2 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 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 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 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. 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 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).

Comment [ABF96]: See also:
- Ting, T.-f. 1998. The thermal environment of northern spotted owls in northwestern California: Possible explanations for use of interior old growth and coastal early successional stage forest. MS Thesis, Humboldt State University, Arcata, California.
- Barrows, C. 1981. Roost selection by spotted owls: an adaptation to heat stress. Condor **83**:302-309.
- Barrows, C., and K. Barrows. 1978. Roost characteristics and behavioral thermoregulation in the spotted owl. Western Birds 9:1-8.

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

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

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

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

Comment [ABF97]: See my General Comment 5 under the THREATS section

Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-August) and winter months (December-February) separately. Comparing the 30-year average with the 5-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 sever 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, Barrowclaugh 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 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 1,970[3] 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 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

[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.

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 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 (Gutiérrezet 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 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; 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.

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).

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

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 a. 2015). Spotted Owl territories having Barred Owl detections ranged between 0-37 within the same timeframe (Franklin et al. 2015).

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.

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 were268 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). When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed (Diller 2012).

During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97% adutls, 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 at 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 (Gutiérrezet al. 1995, Mazur et al. 2000, Gutiérrezet 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).

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.

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).

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

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 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.).

Comment [ABF103]: But this is somewhat contradicted in the next paragraph.

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 [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

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 Hippoboscid flies on 62 of the 382 Northern Spotted Owls captured over five years between April and September, with higher prevalence in adults that 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 Hippoboscid 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).

Comment [ABF106]: I would couch this in terms of secondary poisoning

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 bromadiolone) 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 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.

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.

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytopthora 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. *Phytopthora 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.

Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases quickly. Cobb et al. (2009) examined mortality caused by sudden oak death within coastal redwood forests from Sonoma to Monterey counties. 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. 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. The study found that live oak and tanoak survival declined as a function of disease state. Coast live oak survival was 11.7 to 15.8 years for asymptomatic trees; 7.5 to 11.7 years for trees 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).

After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi and insects is common and impacts survival times. 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. 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 (m^2/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).

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 course 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 (Tempel 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 course 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,

> "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).

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.

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 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance with the presence of hikers (Swarthout and Steidl 2003).

It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the level to which these activities may impact owl behavior, reproduction and overall survival 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

There had previously 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 provides compelling evidence that a population bottleneck may have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from

352 Northern Spotted Owls from six regions across the range which included limited samples from the northern portion of the California Klamath Province.

> Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades) bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic variation and hence effective population size, do not necessarily indicate a decline in actual (demographic) population size (Funk et al. 2010) "… it is important to keep in mind that reductions in [effective population size] (detected with bottleneck tests) are different than reductions in demographic population size (detected with demographic field studies) and reductions in one of these parameters does not necessarily result in a change in the other." (Funk et al. 2010)

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 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.

<u>California Forest Practice Rules</u>

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 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the broader home range (1.3 mile radius).

The most recent research on Northern Spotted Owl habitat requirements in California and southern Oregon have demonstrated a link between owl fitness and the amount of types of habitat, structural characteristics, and spatial configuration in a home range. This requirement for habitat heterogeneity is consistent with the general approach incorporated in the Forest Practice Rules. Although study design has varied across the major research studies, some consistent patterns have arisen. In order to support productive Spotted Owl territories, a minimum amount of older forest must be retained in the core area. The definition of 'older forest' evaluated in studies has varied, but consistently includes late-seral forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older forest in an approximately 400 acre core area.

Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness. Results indicate that in order to support a productive Northern Spotted Owl territory, no more than about 50% of a home range should consist of nonhabitat.

The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls. The total acreage of recommended retention in the USFWS guidance does not differ from that found in the Forest Practice Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range must be retained in habitat. However, based on assessment of core use areas in the interior portion of the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations in line with core use areas evaluated in recent work. The most significant change in the revised USFWS recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained near the core is consistent with the literature.

A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised USFWS recommendations (see Table 22 for the interior portion of range in California) shows large discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres). This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500 acres 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 under Forest Practice Rules, a definition that is considered low quality foraging habitat by the USFWS; therefore there is no requirement in the Forest Practice Rules for this habitat include nesting or roosting habitat under the Forest Practice Rules.

Our assessment of selected activity centers shows that the habitat retention guidance in the Forest Practice Rules are not always met, indicating that harvest is impacting Northern Spotted Owl at some locations. Of the activity centers evaluated, several experienced very high acreages of harvest at both the broad home range and in the core area, which would have resulted in territories that do not meet the USFWS recommendation for take avoidance, and would have resulted in declines in survival and fitness of the local owls.

Documentation of habitat type, amount, and distribution present around activity centers after THPs are implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if minimum retention requirements in the Forest Practice Rules are implemented as written, there is still the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts that have occurred in recent years.

The THP review and post-harvest follow-up process should ensure that the best scientific information is being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a sample of activity centers indicates that it is not universally applied and that insufficient habitat has been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

Salvage Logging

Several variables complicate the interpretation of owl response to fire, including variation in fire severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing and duration of research post-fire. Regardless, several studies 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. Although hampered by small sample size, incidental observations have documented declines in occupancy of burned areas following salvage logging. Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction probabilities, although the impacts of salvage logging were observed only in combination with other factors.

The presence of snags has been suggested as an important component of prey habitat and as perch sites for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub and herbaceous cover and number of snags, may be impacted by salvage logging.

Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the fire itself, by removing important structural elements and removing important prey habitat. The available information suggests that salvage logging reduces the probability that spotted owls will use burned areas and has resulted in declines in occupancy, either through abandonment or declines in survival.

Wildfire

Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994, after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to wildfire, and most of this loss has occurred in the Klamath Province.

The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to use burned areas extensively, although nesting and roosting general occurred only in unburned or low-severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

Conversely, Northern Spotted Owls in southern Oregon were shown to have declines in occupancy following fire. These declines resulted from both high extinction rates in burned areas and low colonization rates.

Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to experience declines in survival. Food limitation in burned areas may have been a factor in declining survival rates. These observed declines in southern Oregon may be confounded by the occurrence of post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in the year following fire; these owls were not tracked to investigate potential longer-term effects.

Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance for foraging.

The available information suggests that wildfires can have positive effects on Northern Spotted Owls when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without removing important nesting and roosting habitat components at the territory scale. However, uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be used as a management tool.

Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades, fires have become more frequent and average fire size has increased. In some cases fires have also burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry and hot conditions). Because climate change will likely increase the likelihood of conditions that support fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

Climate Change Impacts to Forest Composition and Structure

Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate projection scenarios specific to California, the most notable response to increase temperature was a shift from conifer-dominated forests (eg., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g., Douglas fir-tan oak) in the northern half of the state), expansion of conifer forests into the northeast portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-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.

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)

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 [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)

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

Comment [ABF111]: Seems the most important impact is rodenticide use, which is not mentiond here or elsewhere in the Summary

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 is reliable estimates across the range or within California, and does not effectively sample nonterritorial floater individuals. Northern Spotted Owl 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 slow process given tree species growth rate (with a possible exception on the coastal redwood forests), and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

One 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. 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

Comment [ABF112]: But see my General Comment 2 under the BIOLOGY AND ECOLOGY OF THE NORTHERN SPOTTED OWL section and physiographic province noted in the 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The study 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. Three provinces located in California were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a stronghold for the population. Even though the complexity of the model may limit its ability to accurately model population estimates, the results suggest that California's population of Northern Spotted Owls is an important component of the range-wide population.

Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for more than two decades to assess demographic parameters such as population growth, survival, fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study areas range-wide. In California, the most recent meta-analysis covering years 1985-2008 reported a 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation study area reported a 2.3% population decline per year through 2012. When converting estimates for population change 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) two study areas in California (Green Diamond Resource Company and Northwest California) showed estimated population declines of about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The ongoing analysis has revealed declines in California between 32 and 55% over the study period.

In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in Washington and Oregon. Although less severe than in Washington and much of Oregon, all three California study areas show declines in survival.

Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in California give us information on current estimates for reproductive success (number of young fledged per monitored site) and survival, and are consistent with a continued decline within all demographic study areas in California. 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 despite weather conditions that would typically support good reproductive success. This was observed on many timber company lands, tribal lands, and National

Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive rate since 2009.

The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study areas in California reflected trends on non-federal lands because two study areas are on non-federal lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal land. However, the authors also suggest that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands because the non-federal lands included in the demographic study areas are managed for owls. Results from the demographic study areas are thought to be 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 large, distributed across a broad geographic region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

Occupancy data is based on the presence or absence of owls from known sites. 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. Although an evaluation of occupancy rates has not been included in previous demographic meta-analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have declined at all three California study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on occupancy by increasing the local territory extinction rate.

Occupancy has been shown to be in decline for areas outside the California demographic study areas as well. For example, the southern Cascades and interior Klamath provinces of California determined occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

It is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of demographic rates across the range indicate the declines in demographic parameters, including population size, have accelerated. The level of decline does not seem to be slowing even with the implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at threats leading to these declines is warranted, including revaluation of the effectiveness or management techniques across the Northern Spotted Owl range in California.

Predation

Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted Owls is not a threat to the population. In the case of documented Barred Owl aggression toward Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities were due to territorial aggression. Given that predation is not considered to be a major threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly manage predation issues.

Competition

Over the last several decades, Barred Owls have gradually moved further into the range of the Northern Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been present the longest (British Columbia and Washington), with fewer detections made in the southern edge of the range (California) where they have been present for a shorter duration. Currently, Barred Owls have been documented in all portions of the Northern Spotted Owl range throughout California, though densities of Barred Owls are unknown.

Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong indication that the two species can coexist over time, sharing the same habitat and prey-base, because there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and not by Barred Owls.

Public workshops held by the USFWS have resulted in four published and one unpublished meta-analyses since 1994 to assess population parameters, such as abundance, trend, and survival. 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 have been more prevalent where Barred Owls density was greatest. Northern Spotted Owl adult survival has declined in a majority of the range where Barred Owls were present, with a more gradual decline noted in California largely attributed to the relatively more recent Barred Owl expansion into this portion of the range. Presence of Barred Owls in or near Northern Spotted Owl territories is also thought to negatively impact fecundity, survival, and occupancy of Northern Spotted Owls.

Comment [ABF113]: See my previous comment about the number and how many publsihed

Comment [ABF114]: I would phrase this as "where barred owl detections are more frequent and widespread"

Experimental studies to remove Barred Owls conducted in California demonstrated that 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 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and longer drier summers.

Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These studies indicate that winter precipitation is closely associated with a decrease in survival and recruitment; population growth was positively associated with wetter conditions during the growing season (May through October) and negatively associated with cold/wet winters and nesting seasons, and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction increased with late nesting season precipitation and decreased with warm temperatures; and owls may be more sensitive to changes in spring time climatic events.

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 sever 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 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where applicable. As new information becomes available, recommendations may be further refined.

Planning and Timber Practices

1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is consistent with the recovery of the species (see RA14).
2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-range planning, setting priorities for scientific research and investigations, and/or when making major decisions affecting the Northern Spotted Owl (see RA5).
3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative opportunities for nonfederal landowners to engage in management strategies (see RA15).
4. Consider long-term maintenance of local forest management infrastructure as a priority in planning and land management decisions (see RA16).
5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of Northern Spotted Owls (see RA21).
6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration, HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
7. Improve thorough documentation of harvest prescription methods within timber harvest plans and a rigorous evaluation of post-harvest levels of foraging, nesting, and roosting habitat.
8. Evaluate the effects of silvicultural practices on important prey species (e.g., flying squirrel, woodrat) and their habitat.

Population Trend and Demographic Parameters

9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if the California population is decreasing, stationary or increasing (see RA2).
10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy across its California range (see RA3).
11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival, population growth and reproductive rates of Northern Spotted Owls in California, and determine if negative impacts of climate change outweigh the positive ones.

Habitat

12. Manage Northern Spotted Owl habitat in a way that accelerates the development of structural complexity and biological diversity that benefits Spotted Owl (see RA6)
13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl habitat) while allowing for other threats, such as wildfire and insects, to be addressed by restoration management actions (see RA32).
14. Conserve Northern Spotted Owl sites and high value habitat to provide additional demographic support to population dynamics (see RA10).
15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to inform decisions concerning the possible development of habitat conservation networks in California (see RA4).
16. Assess habitat requirements for, and barriers to, dispersal in California through research on Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and availability, and habitat modeling.
17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath Province) to assist evaluating landscape-level issues in the Provinces in California, including monitoring and adaptive management actions (see RA7 and RA9).

<u>Wildfire</u>

18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).
19. 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.
20. Conduct experiments to better understand how vegetation management treatments (e.g., thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern Spotted Owl habitat, prey abundance and distribution, and demographic performance (see RA11).
    a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in use of burned areas for foraging warrants additional research on long-term use of burned areas post-fire.
21. Gather information 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.
22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.

23. Develop a process for evaluating the likely effects of post-fire management activities, such as salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate this process into post-fire management decisions.

24. Concentrate post-fire silvicultural activities on conserving and restoring habitat elements that take a long time to develop, such as large trees, medium and large snags, downed wood (see RA12).

Barred Owl

25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy, reproduction, and survival in California (see RA23).

26. Promote experimental removal of Barred Owls within Northern Spotted Owl range, and if lethal removal is deemed a long-term management tool to manage negative effects of Barred Owls, explore methods for implementation within California (see RA22, RA29, and RA30).

27. Investigate the potential for resource partitioning of Barred Owls and Northern Spotted Owls (see RA26).

28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted Owl interactions.

    a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by the presence or absence of Barred Owls, but other unknown factors may also play a role.

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.

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 resource management agencies will allocate funds towards protection and recovery actions may increase.

Economic Considerations

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.

<u>Clearcutting</u>
Section 913.1(b) – Clearcutting regeneration method involves the removal of a stand in one harvest.

<u>Seed Tree</u>
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.

<u>Seed Tree Seed Step</u>
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)].

<u>Seed Tree Removal Step</u>
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).

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.

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.

<u>Shelterwood Removal Step [Coast only]</u>
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.

<u>Shelterwood Removal Step [Northern and Southern]</u>
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”.

<u>Selection/Group Selection</u>
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.

<u>Transition</u>

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.

<u>Commercial Thinning</u>

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.

<u>Sanitation-Salvage</u>

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.

<u>Special Treatment Area</u>

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.

<u>Rehabilitation</u>

Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7) prior to any timber operations on such lands, an area may be harvested provided it is restocked in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be included in the THP. The regeneration plan shall include site preparation, method of regeneration, and other information appropriate to evaluate the plan.

Fuelbreak/Defensible Space
Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a shaded fuel break or defensible space in an area to reduce the potential for wildfires and the damage they might cause.

Variable Retention
Section 913.4(d) - Variable retention is 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.

Conversion
Section 1100 – within non-timberland production zone (TPZ) timberland, transforming timberland to a nontimber growing use through timber operations.

Alternative Prescription
A written analysis of preharvest and postharvest timber stand conditions and a description of the silvicultural practices and systems to be used in lieu of the standard methods. 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.
Section 913.6 – When an Alternative method is used, the plan must include a statement of which silvicultural method in the current District rules is most nearly appropriate or feasible and an explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how the proposed alternative prescription will differ from the most nearly feasible method in terms of securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in terms of fire, insect and disease protection.

NonTimberland Area
Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land, other than land owned by the federal government and land designated by the board as experimental forest land, which is available for, and capable of, growing a crop of trees of a commercial species used to produce lumber and other forest products, including Christmas trees.

Road Right of Way
No strict definition

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

such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with characteristics of topographic relief and aspect which alter microclimates.

Functional Roosting Habitat during the territorial breeding season, consists of stands where average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers provide an average of at least 40% canopy closure but the stand can have a high degree of variability. Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for protection from various environmental conditions, including wind, heat, and precipitation.

Owl Habitat means Type A, B, or C owl habitat or those areas with functional foraging habitat, functional nesting habitat, and functional roosting habitat which support the owl's biological needs for breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls are known to occasionally inhabit less than optimal forest structure, local information can be used to justify the modification of functional habitat definitions.

Type A Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy layers: The stand has two distinct tiers or is multi-layered with dominant conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.

2. Canopy Closure: The canopy closure of conifers greater than 120 ft. tall (or greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.

3. Large Trees: The density of conifers greater than 35 in. dbh averages more than nine stems per acre and not less than six stems per acre and includes a component of trees with sparse, broken, or dead tops.

4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre and not less than 8 stems per acre.

5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type B Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy Layers: Moderately to strongly two-tiered or multi-layered with dominant conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.

2. Canopy Closure: The canopy closure of conifers greater than 100 ft. tall (or greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.

3. Large Trees: The density of conifers greater than 35 in. dbh averages more than six

stems per acre and not less than two stems per acre.

4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 25 stems per acre and not less than 20 stems per acre.

5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type C Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy Layers: Uniform to moderately layered with dominant conifers or hardwoods 50 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.

2. Canopy Closure: The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.

3. Large Trees: The density of conifers greater than 35 inches dbh averages less than six stems per acre and may be absent.

4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre, but may be absent.

5. Small Trees: The density of conifers or hardwoods less than 18 inches dbh averages more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the stand, including small, medium, and large trees is greater than 10 inches.

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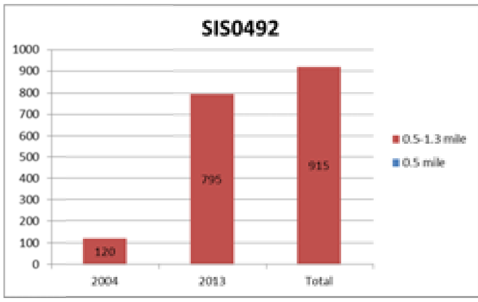
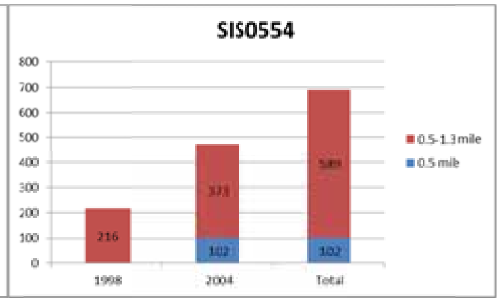
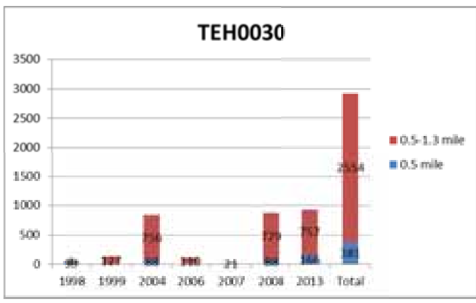
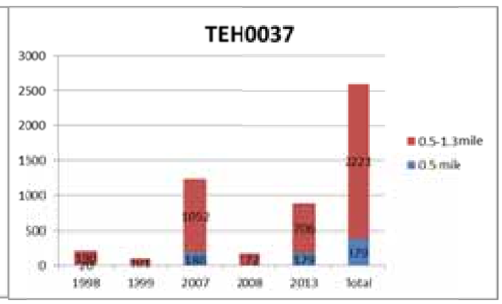
Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

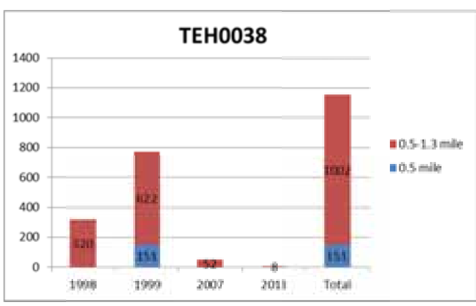
THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

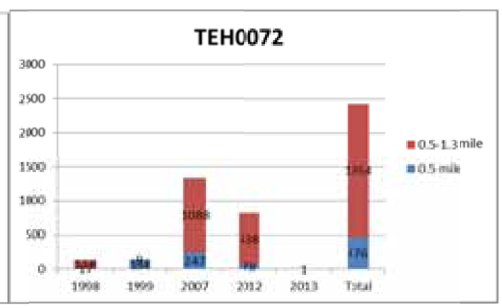












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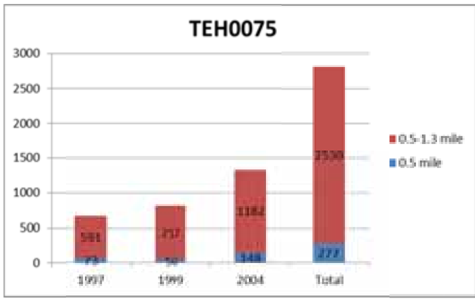

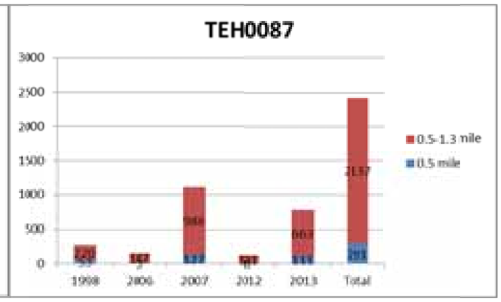

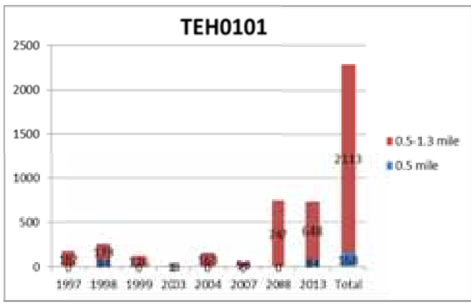

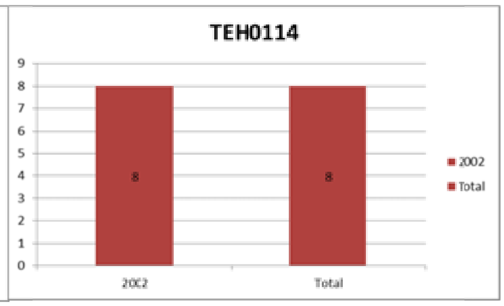

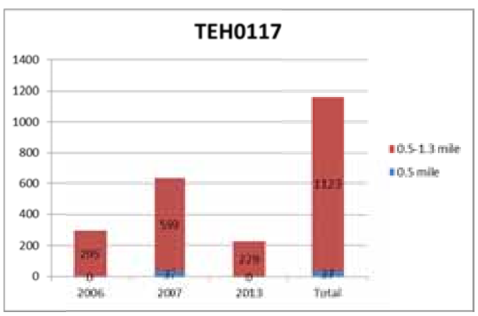

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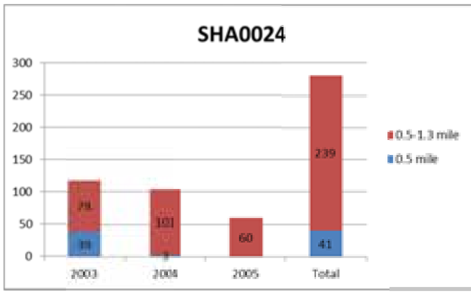
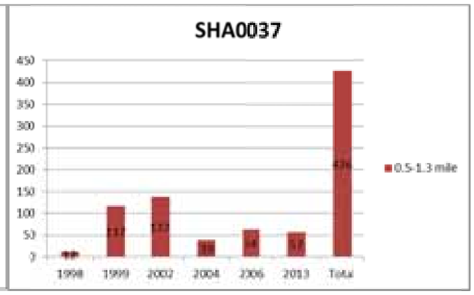
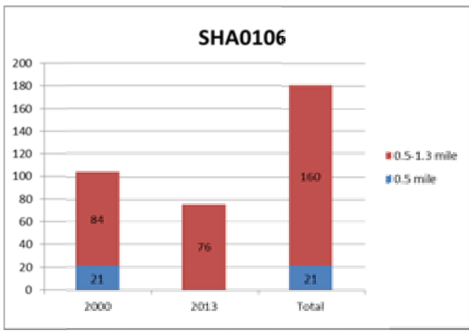
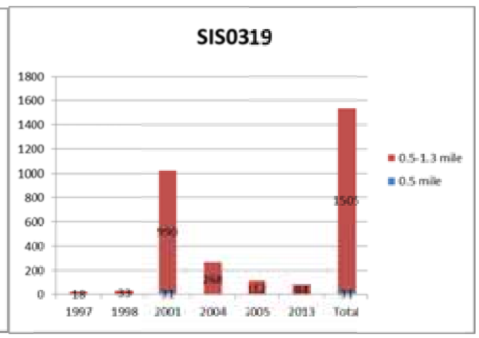
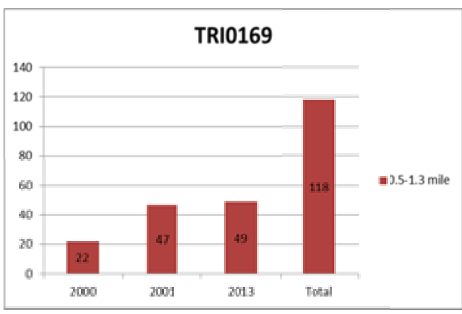
THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC

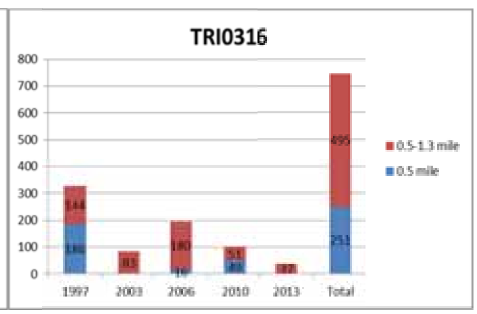












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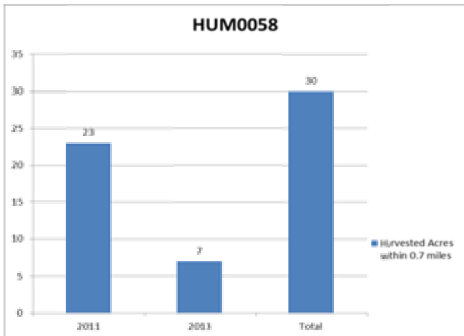
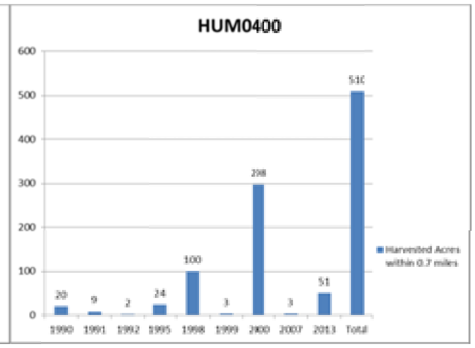
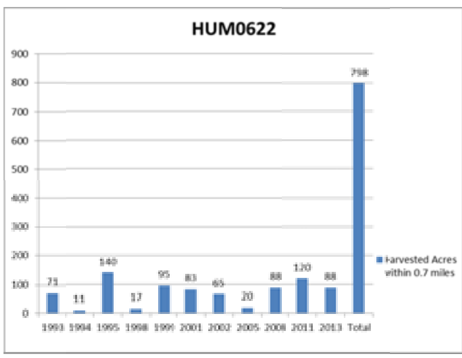
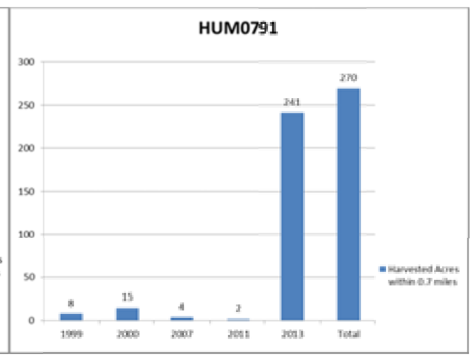
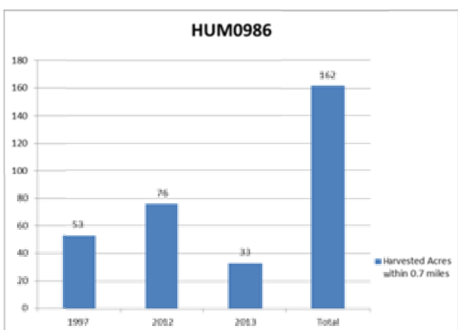
THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

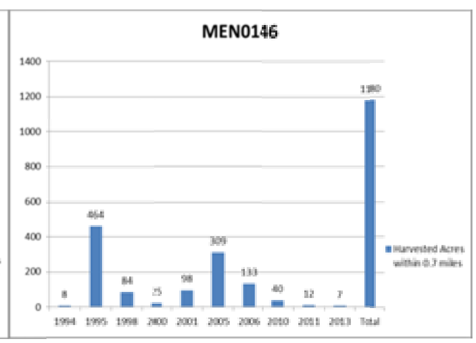












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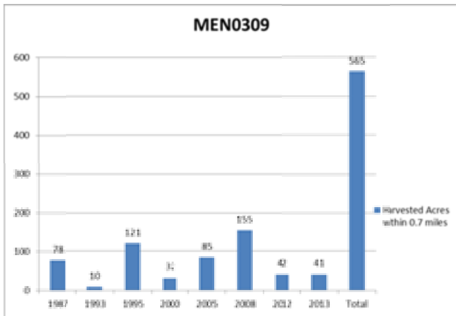

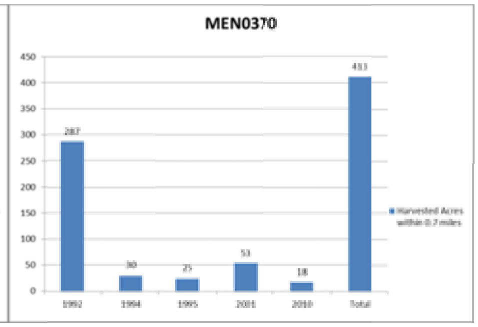

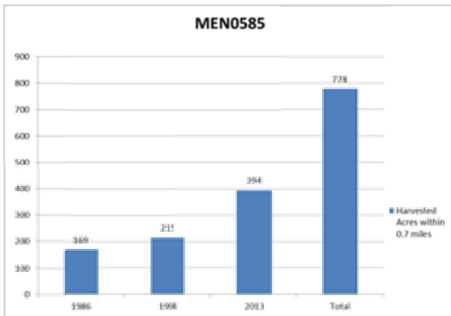

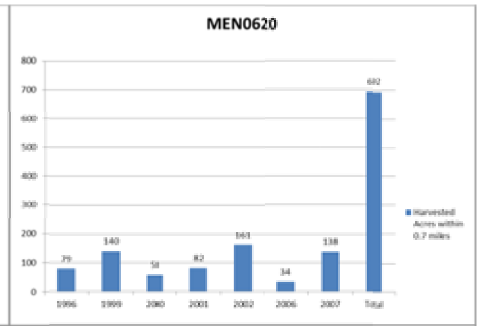

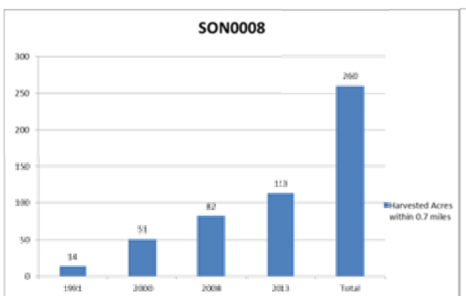

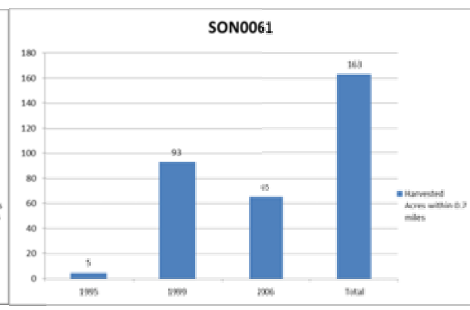

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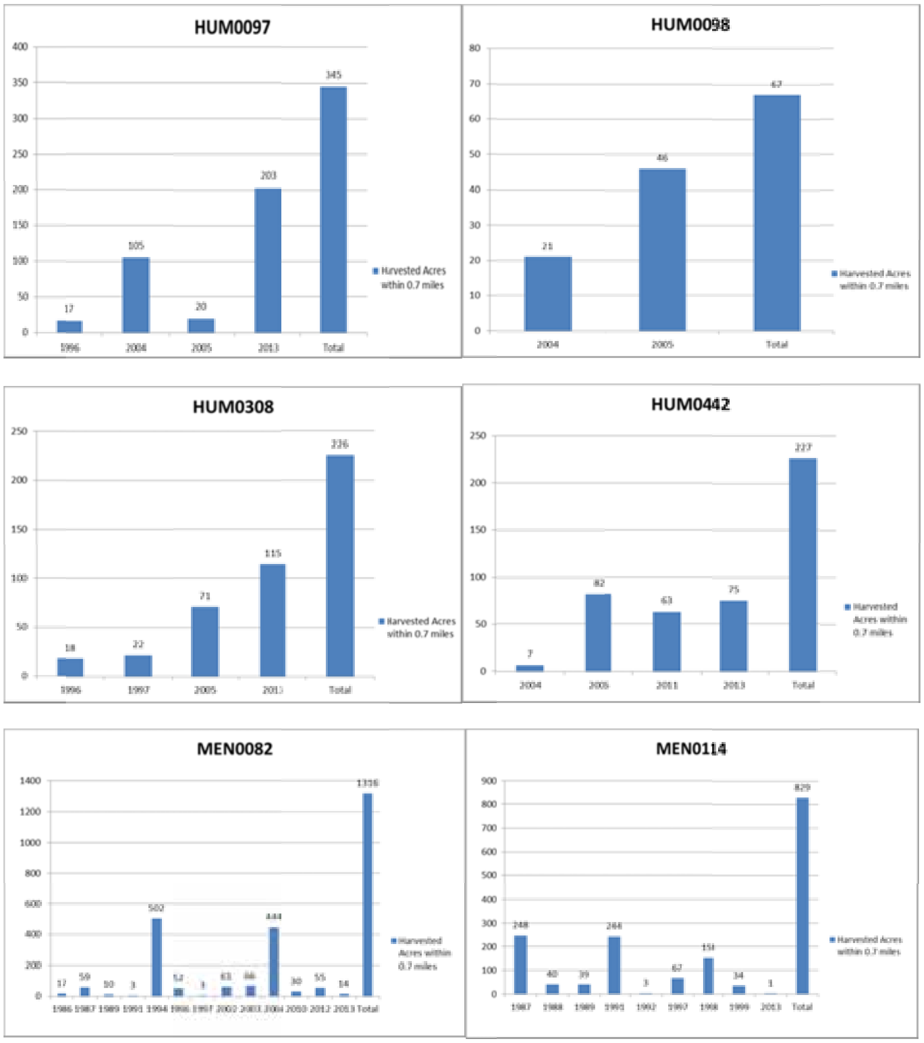
THP's utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.



Appendix 4. List of Acronyms and Abbreviations

AC	Activity Center
AMA	Adaptive Management Areas
AR	Anticoagulant Rodenticides
BLM	Bureau of Land Management
Board	Board of Forestry and Fire Protection
BO	Biological Opinion
BOE	Board of Equalization
BOF	State Board of Forestry and Fire Protection
CA State Parks	California Department of Parks and Recreation
CAL FIRE	California Department of Forestry and Fire Protection
Caltrans	California Department of Transportation
CBD	Center for Biological Diversity
CD	Consistency Determination
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CCAA	Candidate Conservation Agreement with Assurances
CDFW	California Department of Fish and Wildlife
CI	Confidence Interval
CNDDB	California Natural Diversity Database
Commission	Fish and Game Commission
CPV	Canine Parvovirus
CSA	Conservation Support Areas
CWHR	California Wildlife Habitat Relationships
DBH	Diameter at Breast Height
DSA	Density Study Area
Department	California Department of Fish and Wildlife
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
ESA	Federal Endangered Species Act
FEIS	Final Environmental Impact Statement
FRGP	Fisheries Restoration Grant Program
FGS	Fruit Growers Supply Company
FEMAT	Forest Ecosystem Management Assessment Team
FIA	Forest Inventory Analysis
FMP	Forest Management Plan
FPA	Forest Practice Act
FRI	Fire Return Interval
FSC	Forest Stewardship Council
GDR	Green Diamond Resource Company study area
GDRC	Green Diamond Resource Company
ITP	Incidental Take Permit
ITS	Incidental Take Statement
JDSF	Jackson Demonstration State Forest
HCP	Habitat Conservation Plan
HFP	Habitat Fitness Potential

HCVF	High Conservation Value Forests
HUP	Hoopa Indian Reservation study area
HRC	Humboldt Redwood Company
LSA	Late-Successional Areas
LSAA	Lake or Streambed Alteration Agreement
LSR	Late-Successional Reserve
MBF	1,000 board-foot
MIS	Management Indicator Species
MMCA	Marbled Murrelet Conservation Areas
MRC	Mendocino Redwood Company
NCA	National Conservation Area
NCCP	Natural Community Conservation Plan
NIPF	Non-industrial private forest
NPS	National Park Service
NSO	Northern Spotted Owl
NTMP	Nonindustrial Timber Management Plans
NTO	Notice of Operations
NWC	Northwest California study area
NWFP	Northwest Forest Plan
ORV	Off Road Vehicle
PCB	Private Consulting Biologists
PFT	Pacific Forest Trust
PL	Pacific Lumber Company
PRNS	Point Reyes National Seashore
PSU	Primary Sampling Unit
REF	Suppressed reproduction and growth
RNSP	Redwood National and State Parks
ROD	Record of Decision
RPF	Registered Professional Foresters
SEIS	Supplemental Environmental Impact Statement
SHA	Safe Harbor Agreement
SOMP	Spotted Owl Management Plans
SOP	Spotted Owl Expert
SORP	Spotted Owl Resource Plan
SFI	Sustainable Forestry Initiative
SP	State Park
SPI	Sierra Pacific Industries
TCP	Timberland Conservation Planning Program
THP	Timber Harvest Plan
TPZ	Timber Production Zone
UCNRS	UC Natural Reserve System
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USFS	United States Forest Service
WCSA	Willow Creek Study Area
WLPZ	Watercourse and Lake Protection Zones

WNV West Nile virus

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 caurine 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 <u>0.042 owls/km^2</u> for the northern portion and <u>0.192 owls/km^2</u> 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, <u>0.137 owls/km^2</u> 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/mi^{2}of area surveyed, which translates to 0.86 owls/2.59 km^2 or 0.33 owls/km^2. 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
Cc: Battistone, Carie@Wildlife; 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
Wildlife Biologist
U.S. Fish and Wildlife Service
2600 SE 98th Ave., Suite 100
Portland, OR 97266

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

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: 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

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, section2074.6, 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.

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.

> 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, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.

> 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 such migratory nongame bird except as provided by rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory Treaty Act.

California Board of Forestry and Fire Protection

The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire Protection (CAL FIRE) have designated Northern Spotted Owl as a “Sensitive Species” as identified in the California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules). These sections also define Northern Spotted Owl -related terminology, including “activity center”, “Northern Spotted Owl breeding season”, and “Northern Spotted Owl Evaluation Area.” Specific requirements for the disclosure of information on Northern Spotted 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 sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and related activities, would be avoided according to the criteria for determining take avoidance found in Section 919.10. Other 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 nests through buffers and avoidance of sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the protections afforded to late successional forests, which are a component of Northern Spotted Owl habitat.

International Union for Conservation of Nature

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

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,

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 km^2 (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

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).

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 varation in home range sizes across the sepcies' range, and then discussing data on numbers of observed activity centers.

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 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/km^2) 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/ km^2 of habitat) at 0.544 owls/km^2 (95% CI = 0.495-0.592) and 0.660 owls/km^2 (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km^2. 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/km^2±0.006, 0.351 owls/km2±0.011, and 0.313 owls/km^2±0.017 for Klamath, Korbel and Mad River regions respectively, with an overall mean density of 0.209 owls/km^2±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbel, 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/km^2 in the northern portion of their land in Humboldt County, and 0.78 owls/km^2 in southern portions. Sierra Pacific Industry reported 0.450 owls/km^2 between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km^2 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/km^2 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?

Redwood Company (HRC) reported 1.22 occupied territories/km^2 and 2.23 owls/km^2 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.

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.

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

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.

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 m^2/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 Kernal, and Adaptive Kernal) 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 forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference between breeding and nonbreeding seasons. The study showed core area size, annual home range and breeding home range size increased as amount of hard edge increased (Schilling et al. 2013). In their study site 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, with ranges being 3.5 times larger during the fall and winter months.

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, 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 (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 (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). Forsman et al. (2015) attributes the larger winter home range to prey dynamics and exploratory excursions in search of better habitat.

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 Kernal, and AK = Adaptive Kernal.

	Annual Home Range in hectares (+/- one Standard Error)					
Area	MCP	MMCP	95% FK	95% AK	Core area in hectares	Source
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

Dispersal

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

In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent 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 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). While the only data available on dispersal pertains to Northern Spotted Owls in Washington and Oregon, and California Spotted Owls in California, we can extrapolate that Northern Spotted Owls in California act similarly, because, while the populations are genetically and geographically distinct, they still share many ecological and behavioral characteristics.

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

Habitat Requirements

Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al. 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 (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. 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 Gutiérrez1990 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 Gutiérrez1999, Swindle et al. 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.

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."

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 (tress >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 for capture by owls (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 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry

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 (Gutiérrez1996, 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 diameter[1] 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 m^2/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

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[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.

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 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.

<u>California Coast Province</u>

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

<u>California Klamath Province</u>

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

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

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

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 DBH[1] >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 QMD[2] >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

			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

<u>California Cascade Province</u>

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

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

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

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

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

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

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

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

Habitat Effects on Survival and Reproduction

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

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).

Comment [EMG9]: Will need to be updated with info from Dugger et al. 2015. CA data are included in this latest paper.

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 change[2]) 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

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

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 ≥40%, and overstory canopy coverage of ≥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).

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

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

[a]Size 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.

[b]Size 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.

[c]Franklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types.

[d]Edge 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.

[e]Franklin 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

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 m^2/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

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

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.

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 [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.

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.

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.

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).

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.

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).

Comment [EMG16]: Yes! This is why the previous section is not particularly relevant.

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

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**
Washington				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
Oregon				
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
California				
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.

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 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.

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]
Washington				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
Oregon				
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
California				
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

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

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

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

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

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.

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

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-

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).

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. 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 site occupancy.

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).

In contrast to the above studies at demographic study areas and at other well-monitored areas that showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the 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 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.

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.

Source-Sink Dynamics

Pulliam (1988) was the landmark publication on source-sink population dynamics. Since then, 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 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

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.

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
	Modeling Regions		
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
	Physiographic Provinces		
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

to the California Coast Range, California Cascades and Oregon Klamath provinces, with net flux most notable to the California Coast Range province.

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

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
Modeling Regions			
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
Physiographic Provinces			
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

Schumaker et al. (2014) results suggest that California's population of Northern Spotted Owls is a significant component of and source to the range-wide population. As a source, the Klamath region populations provide a source of owls to sink populations on the Coast and Cascade ranges. This concept is central to protection of owl habitat, especially dispersal habitat, for the continued persistence of Northern Spotted Owls across their range.

Existing Management

Land Ownership Patterns in Northern Spotted Owl Range

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

Comment [EMG22]: Citation?

Comment [EMG23]: Define this acronym.

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 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)
Total	*24,465,790 (100)*

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.

However, silviculture treatments (including thinning in stands less than 80 years old west of the Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district plans as being withdrawn from timber production and include recreational and visual areas, back country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with smaller amounts of reserved lands on the coast (Figure 11).

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

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

<u>Late Successional Reserves:</u>

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

- 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:

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., 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

- Retention of large snags and down logs within thinning units
- Retention of hardwoods
- 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.

<u>Headwaters Forest Reserve</u>

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.

<u>King Range National Conservation Area</u>

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

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

National Park Service

Redwood National and State Parks

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

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

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

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

In 1978, Congress expanded RNSP to include 38,000 acres that had been logged between 1950 and 1978 using clearcut tractor logging. With the expansion of the RNSP, commercial operations including active forest management and silviculture thinning ceased which resulted in second-growth forest conditions "considered unhealthy from both a silviculture and an ecological standpoint" (NPS 2008, NPS 2009a).

Many of the second-growth forest stands were primarily high-density, even-aged Douglas-fir stands with little canopy structure and no understory development. The focus of second-growth forest restoration is to reduce stand density (thinning) to promote growth of remaining trees while protecting adjacent old-growth forests, as well as maintaining water quality in riparian habitats, minimizing tanoak tree disturbance, and minimizing excessive fuel build-up on the forest floor.

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

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

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

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

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

<u>Point Reyes National Seashore and Muir Woods National Monument</u>

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

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

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

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

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

- Treatment activities or any noise generation above ambient noise levels will not occur within 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as surveys conforming to accepted protocol have determined that the site is unoccupied or non-nesting or nest failure is confirmed.
- Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially alter the percent cover of canopy overstory and will preserve multilayered structure. When shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency vehicle clearance.
- Prior to fire management activities, project areas will be surveyed for the presence of dusky footed woodrat nests. If feasible, woodrat nests will be protected.

- Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a determination is made that the native tree presents a clear hazard in the event of a fire or cutting is the only option to reduce high fuel loading.
- The fire management officer will arrange for qualified biologists to conduct post-project monitoring to determine short- and long-term effects of fire management actions on activity centers if resources are available.

Tribal Lands

Hoopa Valley Indian Reservation

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

The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late successional reserves to the north, south, and east, and Redwood National Park to the northwest. The reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40 pairs of owls at all times during the planning period. However, the plan notes this number of Northern Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

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

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

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

Yurok Indian Reservation

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

The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for intensive surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites. The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on disturbance activities within 0.25 mile of Northern Spotted Owl nest.

Round Valley Indian Reservation

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

Nonfederal Land

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

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

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

A Timber Harvesting Plan (THP) is generally the environmental review document submitted by landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment. THPs are prepared by Registered Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These biologists would become the first "designated biologists" who would consult on proposed THPs.

Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules and procedures that would be adopted in the event of listing. The rules identified descriptions of Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for timber operations to avoid take. The rules called for consultations between plan proponents and Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to amend the initially adopted emergency rules; amendments to the rules occurred several times as knowledge of the Northern Spotted Owl increased and with experience gained through implementation of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] in March 1991, 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.

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

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

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

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

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

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

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

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

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

Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol, breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol was revised (USFWS 2012).

When consultations with the USFWS were required, they consisted of a field review of the proposed THP area, an evaluation of the pre-harvest and predicted post-harvest habitat typing (its suitability for nesting, roosting, or foraging), the sufficiency of habitat retained post-harvest within 500 feet, 0.7 mile and 1.3 mile of owl ACs, and an evaluation of the adequacy of the surveys that were conducted (i.e.

timing, location, interpretation of results) and their consistency with the USFWS protocol. When appropriate, the Department designated biologists would evaluate or propose THP-specific habitat and temporal buffers that differed from standard Forest Practice Rules habitat retention and seasonal restriction requirements that would be adopted as enforceable conditions of THPs.

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

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

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

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

- Other emerging and compelling forestry sector conservation issues required Department staff’s attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related workload).
- The Department “Timber Harvest Assessment Program” (later to become the “Timberland Conservation Planning Program”) budget did not include funding specifically for consultations.
- Staffing of USFWS offices with wildlife biologists had increased.
- The Department felt CAL FIRE and USFWS staff were capable of review, approval, and assessment of THPs and NTMPs.
- The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- The scope, quality and conformance of owl-related information with Forest Practice Rules requirements appeared to have stabilized after approximately six years of implementation.

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

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

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

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

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

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.

13 THPs from Interior Counties	Acres	62 THPs from Coastal Counties	Acres
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

habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat from Forest Practice Rules guidelines.

Forest Practice Rules guidelines under Option (g) are:

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

The USFWS (2009) recommendations are:

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

As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option (e) 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 six interior THPs, four primary habitat types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-habitat.

Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior, and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within 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; 47,344 acres of nesting and roosting).

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).

	6 Interior THPs associated with 14 activity centers, Option (e)		60 Coastal THPs associated with 132 activity centers, Option (e)
	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

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).

	7 Interior THPs associated with 8 activity centers, Option (g)		2 Coastal THPs associated with 6 activity centers, Option (g)
	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

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.), 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.

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.

		Interior, Option (e) Acres harvested		**Interior, Option (g) Acres harvested**	
Activity Center	**Range of Harvest Years**	**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

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

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

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

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

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.

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

Table 17. Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years 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
Interior Counties 1991-2014					
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
Coastal Counties 2005-2014					
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**

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

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**
Interior Counties 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
Coastal Counties 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**

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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

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

The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear that some information was not available to the reviewer due to the nature of the older NTMP narratives, limited public information, and subsequent amendment submissions. There is simply no effective way to track this information in an analysis going back in time. Though Selection and Group Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range, we can infer that owl habitat is retained to some extent; however, we could not 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.

<u>Spotted Owl Management Plans</u>

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

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

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

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

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

Spotted Owl Resource Plans

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

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

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

Habitat Conservation Plans

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

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/mi^2 and 0.32 owls/mi^2, 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

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

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

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

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

According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the

understanding of suitable owl habitat was limited. In 2006, GDRC submitted an application to the USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes the Project, requires the Applicant to comply with terms of the amended BO and its associated incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified the Department that the BO was issued and requested that the Department issue a consistency determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1. In January 2014, the Department found that BO, 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 2014a).

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

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

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 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.

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

Northern Spotted Owl management objective outlined in the plan include:

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.

Northern Spotted Owl conservation measures outlined in the plan include:

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.
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.
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 31site 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.
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.

Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable owl habitat must be provided, if present, and less than 50 percent of this shall be under operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided, within 1.3 miles of each activity center.

5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of each year to make up the minimum number of activity centers designated by the HCP. “Level Two” habitat retention must 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. Following the breeding season, 18 acres around the AC shall be maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC must the in place. For sites, which have been determined to be occupied by a non-nesting pair or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and a 400 foot radius buffer protecting the activity center must the in place. Harvesting of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat retention area.

6. Activity center that are not needed to meet management objectives above shall receive “Level Three” protection measures. These activity centers shall have a 1,000-foot buffer during the breeding season. Timber harvest associated may occur before March 1 or after August 31. During the breeding season, for activity centers which have been determined to be occupied by a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur during the breeding season in the area adjoining the 18-acre habitat retention area.

7. All nest trees shall be marked and be retained if the activity center is harvested.

The HCP outlines an objective to conserve habitat diversity and structural components within the plan area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types and seral stages are maintained across the landscape over the permit period, as well as structural components, to contribute to the maintenance of wildlife species covered under the plan, including the Northern Spotted Owl.

Structural components to be retained include:

1. A certain number and size snags that do not pose a human safety hazard.

2. A certain number and size of green replacement trees, if snags are not present, with a priority for trees other than redwood.

3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or cavities.

4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a maximum of two per acre.

5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given to logs over 30 inches in diameter.

In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in fact 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 2014b).

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

- Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and federal governments to ensure their functions as wildlife reserves in perpetuity.
- Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting habitat in a series of Marbled Murrelet Conservation Areas (MMCAs).
- Conduct a combination of night and daytime surveys and stand searches to locate both known, and any new, owl activity centers.
- Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other conservation elements of the HCP for the retention and recruitment of potential foraging, roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
- Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 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.
- Conduct complete annual censuses to monitor all activity centers on the ownership and to determine numbers of pairs, nesting pairs, and reproductive rates.
- Survey the THP area and a 1,000-foot buffer for new operations, except site preparation, initiated in the period beginning February 21 and ending on or before August 31.
- Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and detection probabilities using accumulated survey data.
- Submit annual reports describing the activities undertaken, results of the Operating Conservation Program, and the proposed Operating Conservation Program activities for the next year for all lands covered by the HCP.

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

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

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

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

Terra Springs LLC HCP

The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa County west of the city of St. Helena, and is located within the California Coast Province. The plan has a 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting, roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees, felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices, retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous

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

federal and private lands have shown that many activity centers are located on or have a home range that extends onto the FGS ownership.

Safe Harbor Agreements

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

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

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

Forster-Gill, Inc., Safe Harbor Agreement

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

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

- Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
- Retain all snags not posing a hazard risk.
- Conduct annual owl surveys on property and within a 500 foot radius around the property.
- Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
- Ensure no harvest occurs within 1,000 ft of any active owls nest site.
- Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and approved by USFWS.
- Conduct timber stand inventories and provide USFWS with data.
- Allow USFWS or other agreed-upon party access to property for monitoring and management 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.

<u>Exemption Harvest</u>

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

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

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

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

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

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

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

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

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

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

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

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

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

The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet from any point of an habitable structure that complies with California Building Code for the purpose of reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2, 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project area shall be increased in the post-harvest stand.

During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS, approximately 41,767,250 acres (1992 to 2013) have been exempted for harvest in counties within the

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.

<u>Emergency Harvest</u>

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.

- Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood, landslide, or earthquake.
- Dead or dying trees as a result of air or water pollution.
- Cutting or removing trees required for emergency construction or repair of roads.
- Cutting and removal of hazardous fuels.
- Treatments to eradicate an infestation of Sudden Oak Death.

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

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

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

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

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

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.

Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak woodlands and prairies is managed through tree removal and burning. Nine management zones within the RNSP delineate the degree of human influence and development on that can occur on the landscape (NPS 2000a).

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

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

University of California Natural Reserves

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

Department Ecological Reserves

Authorized by the California Legislature in 1968 and administered by the Department, the ecological reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats, and to provide areas for education and scientific research. The system now encompasses 119 properties totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur within the range of the Northern Spotted Owl; however there are no management plans for the system or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by BLM, which manages for late seral habitat benefiting Spotted Owls.

Fisheries Restoration Grant Program

As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern Spotted Owls and their habitat are required for each project funded. The purpose of FGRP is to support restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must

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

large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat (see Figure 4).

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

Assessing Habitat Loss through Implementation of the Northwest Forest Plan

The Northern Spotted Owl was listed as threatened under the federal Endangered Species Act in 1990 in part because of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls, ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or degradation from stand replacing wildfire and other disturbances, and loss of amount and distribution of Spotted Owl habitat as a result of past activities and disturbances (USFWS 2011a). To address ongoing decline of Northern Spotted Owl habitat across the range, the NWFP established reserved lands including late-seral reserves, adaptive management reserves, congressionally reserved lands, managed late-successional areas, and larger blocks of administratively withdrawn lands (USDA and USDI 1994) (Figure 11). These are described in more detail above. It was assumed that habitat in reserves would improve over time as successional processes led to more mature forests, however, this is a slow process and so recruitment of habitat conditions on reserves was expected to take many decades. It was also assumed that habitat outside of reserves would continue to decline due to timber harvest and other disturbances but that dispersal habitat would be maintained in order to facilitate movement between reserve lands. Given the continued Northern Spotted Owl population declines and the increasing threat of the Barred Owl, the revised recovery plan recommended conserving occupied sites and unoccupied, high-value Spotted Owl habitat on state and private lands wherever possible (USFWS 2011a).

In order to understand the degree to which the NWFP contributes to conservation of owl habitat, the rangewide trends in habitat are regularly assessed. To date, assessments have been performed at the 10-year and 15-year time points (Davis and Lint 2005, Davis et al. 2011). The recent assessment estimated rangewide habitat changes on federal and nonfederal lands from 1994 through 2007 for California and from 1996 through 2006 in Oregon and Washington by comparing vegetation maps for two bookend time periods. In addition to rangewide changes, trends for each physiographic province and for each state are also reported (Davis et al. 2011). The assessment tracks changes in Northern 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 yat, but there is some summary info from presentations made this summer.

between the reserves. Foraging habitat is not assessed through modeling for the NWFP. Nesting and roosting habitat maps were produced through habitat suitability modeling using several forest structure variables (e.g., percent conifer cover, average conifer dbh, average stand height) and a forest age variable (Davis et al. 2011). Vegetation stands were placed in one of four categories (highly suitable, suitable, marginal, and unsuitable), with highly suitable and suitable categories assumed to represent nesting and roosting habitat (Davis et al. 2011). To assess change, an area was considered to have lost nesting and roosting habitat if its condition moved from suitable or highly suitable to marginal or unsuitable.

Although federal lands contain less than half of the total forest land within the entire range of the Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on nonreserved lands.

Comment [EMG27]: Over what time period?

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

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

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

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

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

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 utilizing 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 the level of information available, particularly older plans, was limited in some cases. Considering 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 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.

Comment [EMG28]: Or would this be "insufficiency" ?

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 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), 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, Bignham 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 varies from 30-60%, with an average of about 45% (USFWS 2009). For a more detailed discussion on 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.

As discussed in the Habitat Requirements section of this report, 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; Franklin et al. 2000). See the Habitat Effects on Survival and Reproduction section of this report for a discussion of HFP and additional studies that have contributed to an understanding of habitat characteristics that provide high HFP. The studies that have evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

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

The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory loss. They found on private timber lands there was a 54% decline in pair status to no response, and a 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change pair status. A lack of owl responses and a lack of suitable habitat to support continued occupancy and survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat characteristics to owl fitness, the USFWS asserted that the Forest Practice Rules were insufficient to 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, Glenn 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).

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			

[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.

Table 22. 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 interior region of 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.

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 form 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

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

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 mi^2) 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

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.

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, 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; much uncertainty remains on the effect of wildfires on the extent and quality of Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates by Spotted Owls have 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 and from southwestern Oregon in the range of the Northern Spotted Owl, 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 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 ≥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).

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

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

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

<u>Historical Fire Regime in the Klamath Province</u>

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 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.

<u>Historical Fire Regime in the Cascades Province</u>

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 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.

<u>Recent Changes in Fire Regimes and Possible Causes</u>

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 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 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 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).

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

Several studies have determined a strong link between changes in fire extent, severity and season, with low precipitation and high temperatures. In addition to land-use history over the last century, climate 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.

<u>Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat</u>

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 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).

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).

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 that 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. McIntrye 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. 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 120,000km^2 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-21^{st} 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 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 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 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. 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 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 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must include structurally complexity to provide nesting options with proper protection. The intensity of disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may increase the level of structural complexity.

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

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

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

Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-August) and winter months (December-February) separately. Comparing the 30-year average with the 5-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 sever 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, Barrowclaugh 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 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 1,970[3] 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 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

[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.

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 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 (Gutiérrezet 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 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; 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.

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).

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.

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 a. 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 were268 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). When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed (Diller 2012).

During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97%

adutls, 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 at 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 (Gutiérrezet al. 1995, Mazur et al. 2000, Gutiérrezet 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 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 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 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 (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).

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 Hippoboscid flies on 62 of the 382 Northern Spotted Owls captured over five years between April and September, with higher prevalence in adults that 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 Hippoboscid 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~~ 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-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 bromadiolone) 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 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.

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.

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytopthora 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. *Phytopthora 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.

Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases quickly. Cobb et al. (2009) examined mortality caused by sudden oak death within coastal redwood forests from Sonoma to Monterey counties. 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. 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. The study found that live oak and tanoak survival declined as a function of disease state. Coast live oak survival was 11.7 to 15.8 years for asymptomatic trees; 7.5 to 11.7 years for trees 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).

After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi and insects is common and impacts survival times. 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. 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 (m^2/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).

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 course 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 (Tempel 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 course 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,

> "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 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance with the presence of hikers (Swarthout and Steidl 2003).

It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the level to which these activities may impact owl behavior, reproduction and overall survival 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

There had previously 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 provides compelling evidence that a population bottleneck may have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from

352 Northern Spotted Owls from six regions across the range which included limited samples from the northern portion of the California Klamath Province.

> Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades) bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic variation and hence effective population size, do not necessarily indicate a decline in actual (demographic) population size (Funk et al. 2010) "… it is important to keep in mind that reductions in [effective population size] (detected with bottleneck tests) are different than reductions in demographic population size (detected with demographic field studies) and reductions in one of these parameters does not necessarily result in a change in the other." (Funk et al. 2010)

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)).

Comment [EMG34]: 1.4. and 6. apply to NSO.

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 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the broader home range (1.3 mile radius).

The most recent research on Northern Spotted Owl habitat requirements in California and southern Oregon have demonstrated a link between owl fitness and the amount of types of habitat, structural characteristics, and spatial configuration in a home range. This requirement for habitat heterogeneity is consistent with the general approach incorporated in the Forest Practice Rules. Although study design has varied across the major research studies, some consistent patterns have arisen. In order to support productive Spotted Owl territories, a minimum amount of older forest must be retained in the core area. The definition of 'older forest' evaluated in studies has varied, but consistently includes late-seral forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older 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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Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness. Results indicate that in order to support a productive Northern Spotted Owl territory, no more than about 50% of a home range should consist of nonhabitat.

The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls. The total acreage of recommended retention in the USFWS guidance does not differ from that found in the Forest Practice Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range must be retained in habitat. However, based on assessment of core use areas in the interior portion of the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations in line with core use areas evaluated in recent work. The most significant change in the revised USFWS recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained near the core is consistent with the literature.

A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised USFWS recommendations (see Table 22 for the interior portion of range in California) shows large discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres). This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500 acres 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 under Forest Practice Rules, a definition that is considered low quality foraging habitat by the USFWS; therefore there is no requirement in the Forest Practice Rules for this habitat include nesting or roosting habitat under the Forest Practice Rules.

Our assessment of selected activity centers shows that the habitat retention guidance in the Forest Practice Rules are not always met, indicating that harvest is impacting Northern Spotted Owl at some locations. Of the activity centers evaluated, several experienced very high acreages of harvest at both the broad home range and in the core area, which would have resulted in territories that do not meet the USFWS recommendation for take avoidance, and would have resulted in declines in survival and fitness of the local owls.

Documentation of habitat type, amount, and distribution present around activity centers after THPs are implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if minimum retention requirements in the Forest Practice Rules are implemented as written, there is still the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts that have occurred in recent years.

The THP review and post-harvest follow-up process should ensure that the best scientific information is being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a sample of activity centers indicates that it is not universally applied and that insufficient habitat has been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

<u>Salvage Logging</u>

Several variables complicate the interpretation of owl response to fire, including variation in fire severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing and duration of research post-fire. Regardless, several studies 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. Although hampered by small sample size, incidental observations have documented declines in occupancy of burned areas following salvage logging. Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction probabilities, although the impacts of salvage logging were observed only in combination with other factors.

The presence of snags has been suggested as an important component of prey habitat and as perch sites for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub and herbaceous cover and number of snags, may be impacted by salvage logging.

Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the fire itself, by removing important structural elements and removing important prey habitat. The available information suggests that salvage logging reduces the probability that spotted owls will use burned areas and has resulted in declines in occupancy, either through abandonment or declines in survival.

Wildfire

Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994, after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to wildfire, and most of this loss has occurred in the Klamath Province.

The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to use burned areas extensively, although nesting and roosting general occurred only in unburned or low-severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

Conversely, Northern Spotted Owls in southern Oregon were shown to have declines in occupancy following fire. These declines resulted from both high extinction rates in burned areas and low colonization rates.

Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to experience declines in survival. Food limitation in burned areas may have been a factor in declining survival rates. These observed declines in southern Oregon may be confounded by the occurrence of post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in the year following fire; these owls were not tracked to investigate potential longer-term effects.

Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance for foraging.

The available information suggests that wildfires can have positive effects on Northern Spotted Owls when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without removing important nesting and roosting habitat components at the territory scale. However, uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be used as a management tool.

Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades, fires have become more frequent and average fire size has increased. In some cases fires have also burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry and hot conditions). Because climate change will likely increase the likelihood of conditions that support fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

Climate Change Impacts to Forest Composition and Structure

Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate projection scenarios specific to California, the most notable response to increase temperature was a shift from conifer-dominated forests (eg., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g., Douglas fir-tan oak) in the northern half of the state), expansion of conifer forests into the northeast portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-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.

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

Comment [EMG37]: What is your conclusion? Start with your statement and then provide your justification.

Few studies have attempted to examine range-wide Northern Spotted Owl population estimates. Survey methodology and effort does not allow for is reliable estimates across the range or within California, and does not effectively sample nonterritorial floater individuals. Northern Spotted Owl 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 slow process given tree species growth rate (with a possible exception on the coastal redwood forests), and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

Comment [EMG38]: Don't start this section with abundance/density. These metrics have NEVER been used to assess NSO population status.

One 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. 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

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.

and physiographic province noted in the 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The study 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. Three provinces located in California were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a stronghold for the population. Even though the complexity of the model may limit its ability to accurately model population estimates, the results suggest that California's population of Northern Spotted Owls is an important component of the range-wide population.

Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for more than two decades to assess demographic parameters such as population growth, survival, fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study areas range-wide. In California, the most recent meta-analysis covering years 1985-2008 reported a 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation study area reported a 2.3% population decline per year through 2012. When converting estimates for population change 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) two study areas in California (Green Diamond Resource Company and Northwest California) showed estimated population declines of about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The ongoing analysis has revealed declines in California between 32 and 55% over the study period.

In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in Washington and Oregon. Although less severe than in Washington and much of Oregon, all three California study areas show declines in survival.

Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in California give us information on current estimates for reproductive success (number of young fledged per monitored site) and survival, and are consistent with a continued decline within all demographic study areas in California. 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 despite weather conditions that would typically support good reproductive success. This was observed on many timber company lands, tribal lands, and National

Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive rate since 2009.

The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study areas in California reflected trends on non-federal lands because two study areas are on non-federal lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal land. However, the authors also suggest that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands because the non-federal lands included in the demographic study areas are managed for owls. Results from the demographic study areas are thought to be 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 large, distributed across a broad geographic region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

Occupancy data is based on the presence or absence of owls from known sites. 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. Although an evaluation of occupancy rates has not been included in previous demographic meta-analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have declined at all three California study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on occupancy by increasing the local territory extinction rate.

Occupancy has been shown to be in decline for areas outside the California demographic study areas as well. For example, the southern Cascades and interior Klamath provinces of California determined occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

It is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of demographic rates across the range indicate the declines in demographic parameters, including population size, have accelerated. The level of decline does not seem to be slowing even with the implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at threats leading to these declines is warranted, including revaluation of the effectiveness or management techniques across the Northern Spotted Owl range in California.

Predation

Comment [EMG40]: What is your conclusion? "Predation is not currently a major threat to the northern spotted owl."

Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted Owls is not a threat to the population. In the case of documented Barred Owl aggression toward Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities were due to territorial aggression. Given that predation is not considered to be a major threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly manage predation issues.

Competition

Comment [EMG41]: What is your conclusion?

Over the last several decades, Barred Owls have gradually moved further into the range of the Northern Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been present the longest (British Columbia and Washington), with fewer detections made in the southern edge of the range (California) where they have been present for a shorter duration. Currently, Barred Owls have been documented in all portions of the Northern Spotted Owl range throughout California, though densities of Barred Owls are unknown.

Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong indication that the two species can coexist over time, sharing the same habitat and prey-base, because there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and not by Barred Owls.

~~Public workshops held by the USFWS~~Workshops held by USGS and USFS in conjunction with other scientists have resulted in four published and one unpublished meta-analyses since 1994 to assess population parameters, such as abundance, trend, and survival. 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 have been more prevalent where Barred Owls density was greatest. Northern Spotted Owl adult survival has declined in a majority of the range where Barred Owls were present, with a more gradual decline noted in California largely attributed to the relatively more recent Barred Owl expansion into this portion of the range. Presence of Barred Owls in or near Northern Spotted Owl territories is also thought to negatively impact fecundity, survival, and occupancy of 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 analyticalworkshops conducted by the scientists involved.

Experimental studies to remove Barred Owls conducted in California demonstrated that 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

Comment [EMG43]: What is your conclusion?

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

Comment [EMG44]: As with previous sections, start with your conclusion statements for each subheading.

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 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and longer drier summers.

Comment [EMG45]: This has the potential to have severe negative effects on NSO habitat.

Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These studies indicate that winter precipitation is closely associated with a decrease in survival and recruitment; population growth was positively associated with wetter conditions during the growing season (May through October) and negatively associated with cold/wet winters and nesting seasons, and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction increased with late nesting season precipitation and decreased with warm temperatures; and owls may be more sensitive to changes in spring time climatic events.

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 sever 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 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where applicable. As new information becomes available, recommendations may be further refined.

Planning and Timber Practices

1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is consistent with the recovery of the species (see RA14).
2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-range planning, setting priorities for scientific research and investigations, and/or when making major decisions affecting the Northern Spotted Owl (see RA5).
3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative opportunities for nonfederal landowners to engage in management strategies (see RA15).
4. Consider long-term maintenance of local forest management infrastructure as a priority in planning and land management decisions (see RA16).
5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of Northern Spotted Owls (see RA21).
6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration, HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).
7. Improve thorough documentation of harvest prescription methods within timber harvest plans and a rigorous evaluation of post-harvest levels of foraging, nesting, and roosting habitat.
8. Evaluate the effects of silvicultural practices on important prey species (e.g., flying squirrel, woodrat) and their habitat.

Population Trend and Demographic Parameters

9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if the California population is decreasing, stationary or increasing (see RA2).
10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy across its California range (see RA3).
11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival, population growth and reproductive rates of Northern Spotted Owls in California, and determine if negative impacts of climate change outweigh the positive ones.

Habitat

12. Manage Northern Spotted Owl habitat in a way that accelerates the development of structural complexity and biological diversity that benefits Spotted Owl (see RA6)

13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl habitat) while allowing for other threats, such as wildfire and insects, to be addressed by restoration management actions (see RA32).

14. Conserve Northern Spotted Owl sites and high value habitat to provide additional demographic support to population dynamics (see RA10).

15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to inform decisions concerning the possible development of habitat conservation networks in California (see RA4).

16. Assess habitat requirements for, and barriers to, dispersal in California through research on Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and availability, and habitat modeling.

17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath Province) to assist evaluating landscape-level issues in the Provinces in California, including monitoring and adaptive management actions (see RA7 and RA9).

<u>Wildfire</u>

18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).

19. 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.

20. Conduct experiments to better understand how vegetation management treatments (e.g., thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern Spotted Owl habitat, prey abundance and distribution, and demographic performance (see RA11).

    a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in use of burned areas for foraging warrants additional research on long-term use of burned areas post-fire.

21. Gather information 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.

22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.

23. Develop a process for evaluating the likely effects of post-fire management activities, such as salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate this process into post-fire management decisions.

24. Concentrate post-fire silvicultural activities on conserving and restoring habitat elements that take a long time to develop, such as large trees, medium and large snags, downed wood (see RA12).

<u>Barred Owl</u>

25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy, reproduction, and survival in California (see RA23).

26. Promote experimental removal of Barred Owls within Northern Spotted Owl range, and if lethal removal is deemed a long-term management tool to manage negative effects of Barred Owls, explore methods for implementation within California (see RA22, RA29, and RA30).

27. Investigate the potential for resource partitioning of Barred Owls and Northern Spotted Owls (see RA26).

28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted Owl interactions.

    a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by the presence or absence of Barred Owls, but other unknown factors may also play a role.

<u>Disease and Contaminants</u>

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.

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 resource management agencies will allocate funds towards protection and recovery actions may increase.

Economic Considerations

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).

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.

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

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

Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7) prior to any timber operations on such lands, an area may be harvested provided it is restocked in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be included in the THP. The regeneration plan shall include site preparation, method of regeneration, and other information appropriate to evaluate the plan.

Fuelbreak/Defensible Space
Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a shaded fuel break or defensible space in an area to reduce the potential for wildfires and the damage they might cause.

Variable Retention
Section 913.4(d) - Variable retention is 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.

Conversion
Section 1100 – within non-timberland production zone (TPZ) timberland, transforming timberland to a nontimber growing use through timber operations.

Alternative Prescription
A written analysis of preharvest and postharvest timber stand conditions and a description of the silvicultural practices and systems to be used in lieu of the standard methods. 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.
Section 913.6 – When an Alternative method is used, the plan must include a statement of which silvicultural method in the current District rules is most nearly appropriate or feasible and an explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how the proposed alternative prescription will differ from the most nearly feasible method in terms of securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in terms of fire, insect and disease protection.

NonTimberland Area
Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land, other than land owned by the federal government and land designated by the board as experimental forest land, which is available for, and capable of, growing a crop of trees of a commercial species used to produce lumber and other forest products, including Christmas trees.

Road Right of Way
No strict definition

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

such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with characteristics of topographic relief and aspect which alter microclimates.

Functional Roosting Habitat during the territorial breeding season, consists of stands where average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers provide an average of at least 40% canopy closure but the stand can have a high degree of variability. Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for protection from various environmental conditions, including wind, heat, and precipitation.

Owl Habitat means Type A, B, or C owl habitat or those areas with functional foraging habitat, functional nesting habitat, and functional roosting habitat which support the owl's biological needs for breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls are known to occasionally inhabit less than optimal forest structure, local information can be used to justify the modification of functional habitat definitions.

Type A Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy layers: The stand has two distinct tiers or is multi-layered with dominant conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.

2. Canopy Closure: The canopy closure of conifers greater than 120 ft. tall (or greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.

3. Large Trees: The density of conifers greater than 35 in. dbh averages more than nine stems per acre and not less than six stems per acre and includes a component of trees with sparse, broken, or dead tops.

4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre and not less than 8 stems per acre.

5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type B Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy Layers: Moderately to strongly two-tiered or multi-layered with dominant conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.

2. Canopy Closure: The canopy closure of conifers greater than 100 ft. tall (or greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.

3. Large Trees: The density of conifers greater than 35 in. dbh averages more than six

stems per acre and not less than two stems per acre.

4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 25 stems per acre and not less than 20 stems per acre.

5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type C Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy Layers: Uniform to moderately layered with dominant conifers or hardwoods 50 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.

2. Canopy Closure: The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.

3. Large Trees: The density of conifers greater than 35 inches dbh averages less than six stems per acre and may be absent.

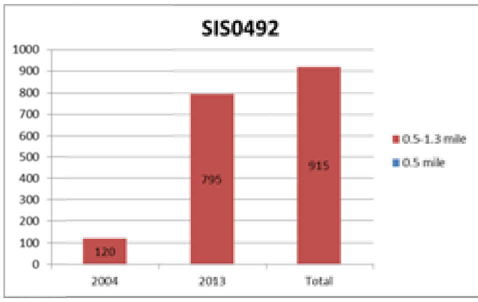
4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre, but may be absent.

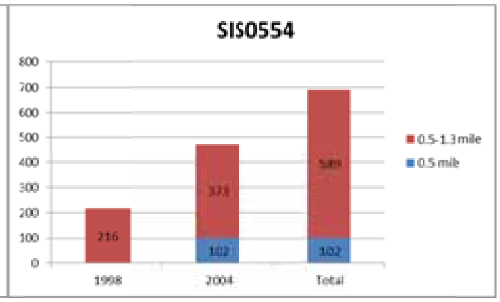
5. Small Trees: The density of conifers or hardwoods less than 18 inches dbh averages more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the stand, including small, medium, and large trees is greater than 10 inches.

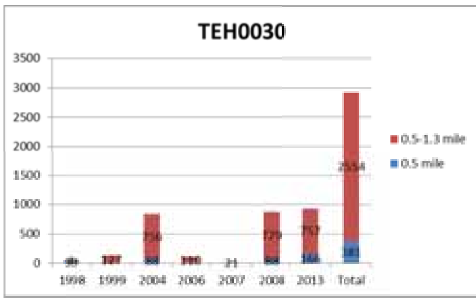
EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: September 8, 2015

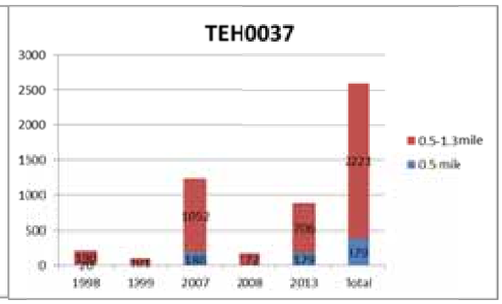
Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

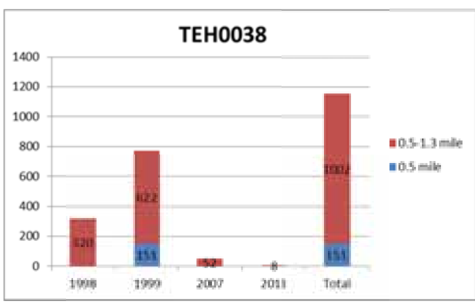
THP’s utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

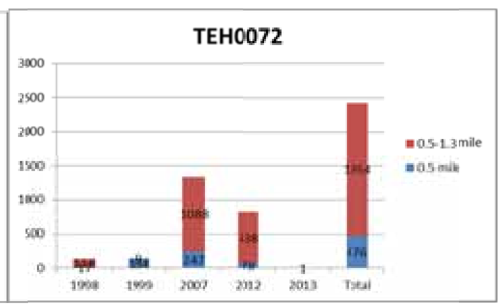












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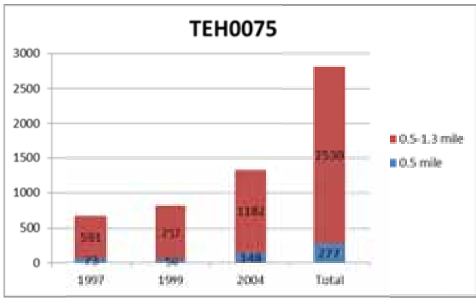
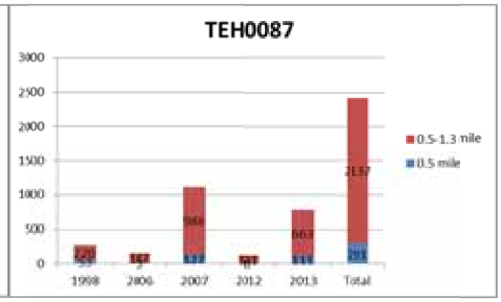
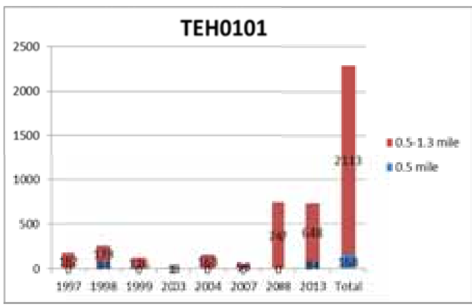
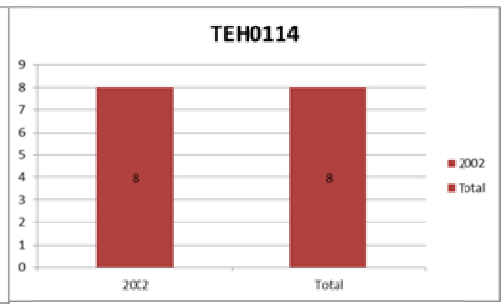
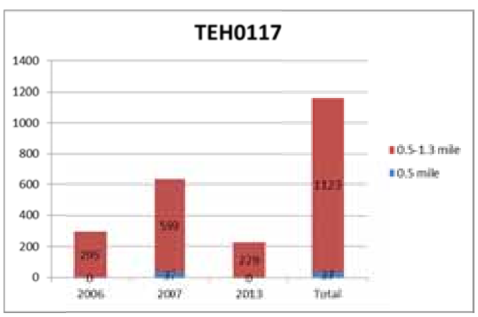




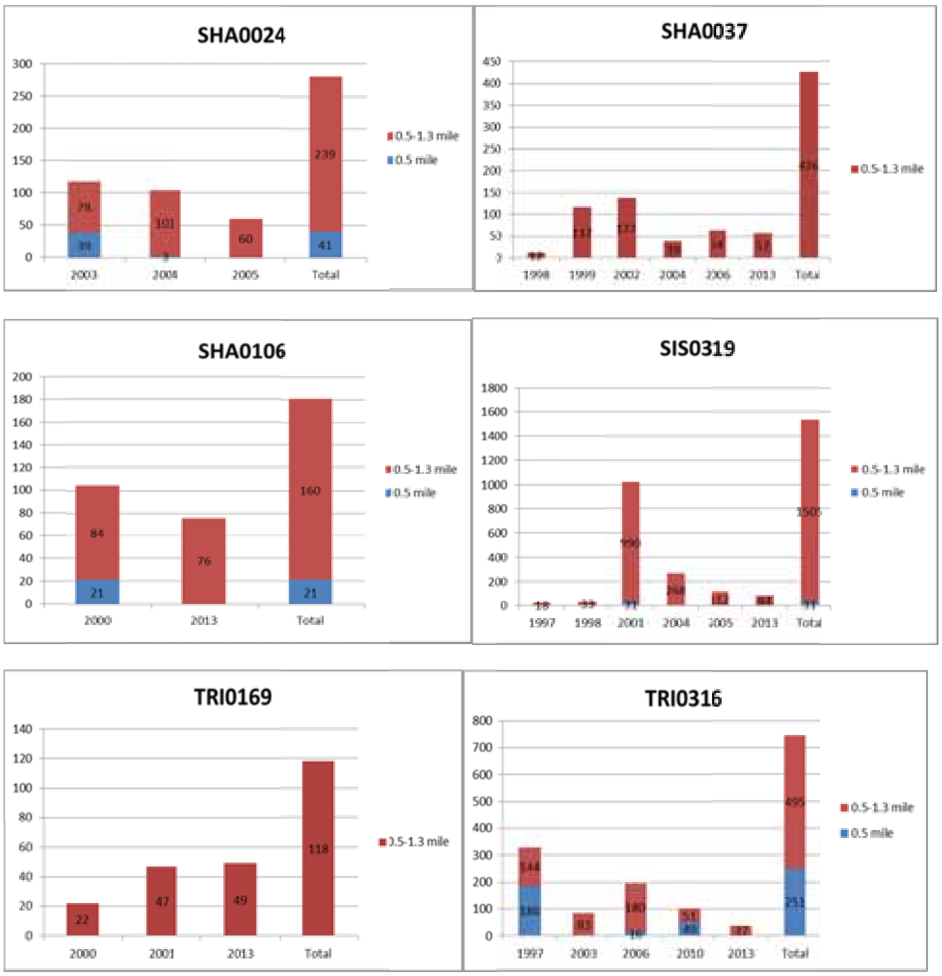






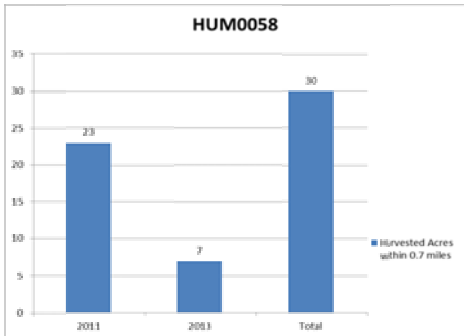
EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: September 8, 2015

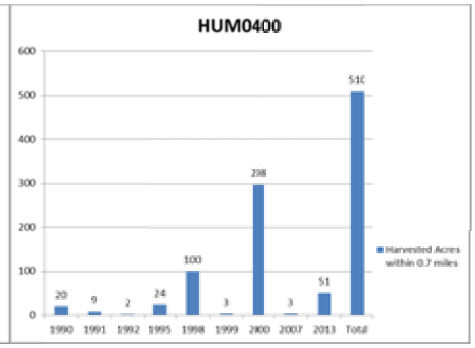
THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC

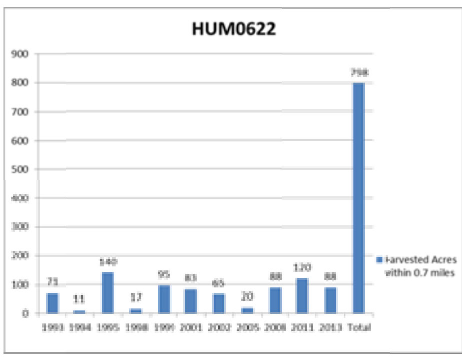


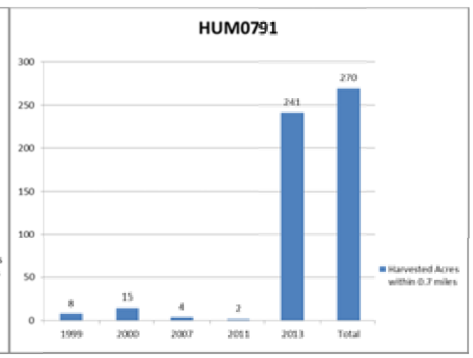
EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: September 8, 2015

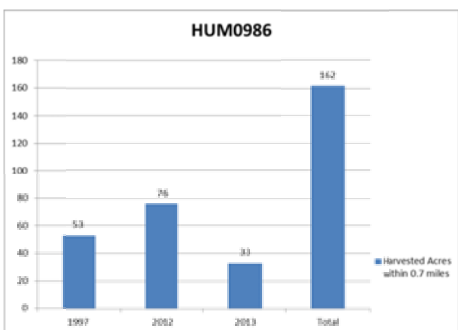
THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

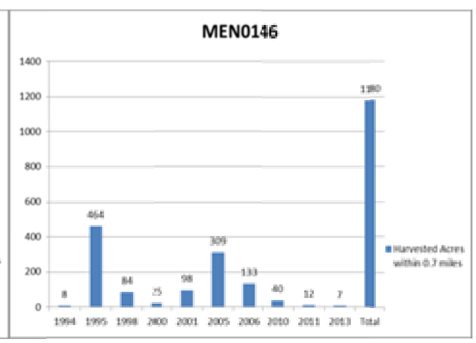












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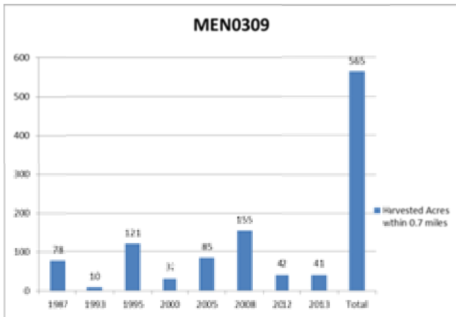
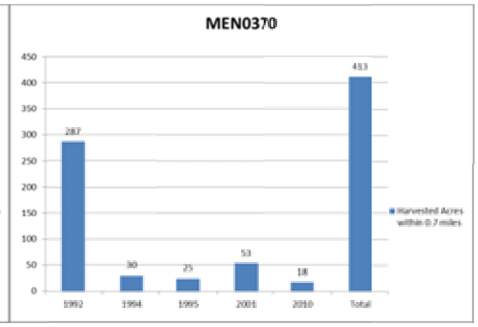
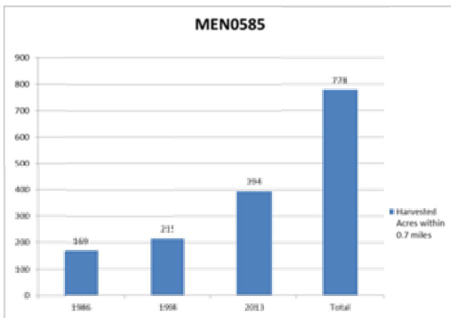
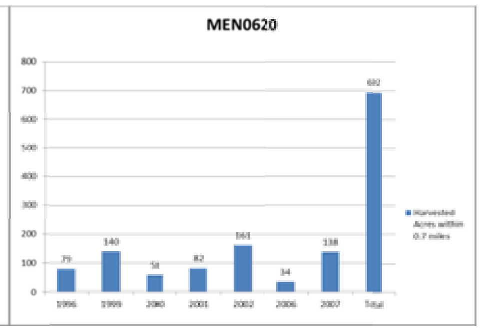
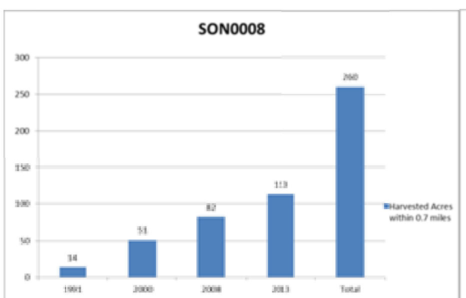
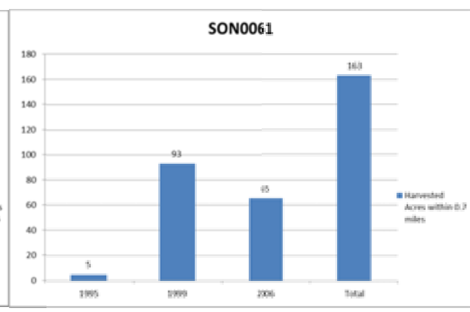




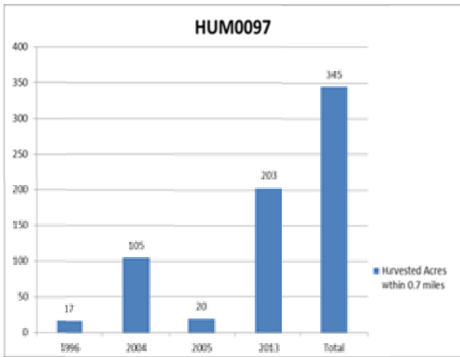


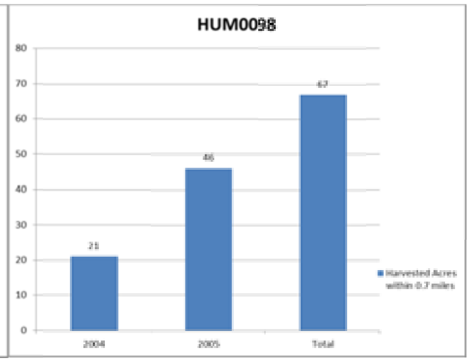


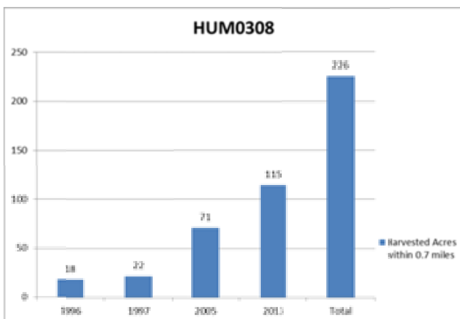


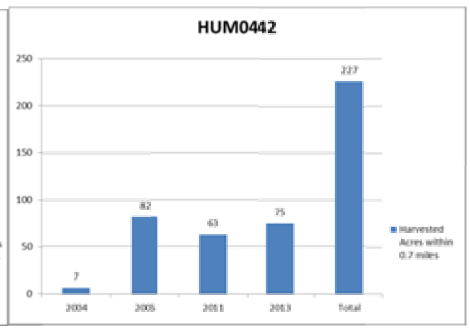


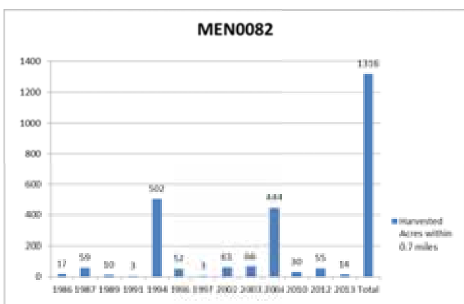
THP's utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

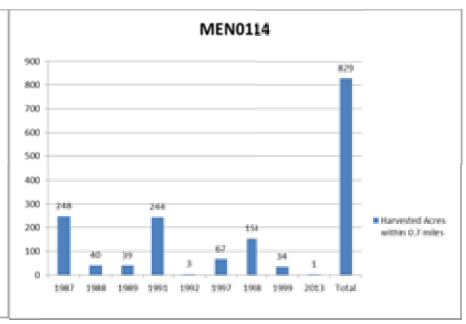












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Appendix 4. List of Acronyms and Abbreviations

AC	Activity Center
AMA	Adaptive Management Areas
AR	Anticoagulant Rodenticides
BLM	Bureau of Land Management
Board	Board of Forestry and Fire Protection
BO	Biological Opinion
BOE	Board of Equalization
BOF	State Board of Forestry and Fire Protection
CA State Parks	California Department of Parks and Recreation
CAL FIRE	California Department of Forestry and Fire Protection
Caltrans	California Department of Transportation
CBD	Center for Biological Diversity
CD	Consistency Determination
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CCAA	Candidate Conservation Agreement with Assurances
CDFW	California Department of Fish and Wildlife
CI	Confidence Interval
CNDDB	California Natural Diversity Database
Commission	Fish and Game Commission
CPV	Canine Parvovirus
CSA	Conservation Support Areas
CWHR	California Wildlife Habitat Relationships
DBH	Diameter at Breast Height
DSA	Density Study Area
Department	California Department of Fish and Wildlife
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
ESA	Federal Endangered Species Act
FEIS	Final Environmental Impact Statement
FRGP	Fisheries Restoration Grant Program
FGS	Fruit Growers Supply Company
FEMAT	Forest Ecosystem Management Assessment Team
FIA	Forest Inventory Analysis
FMP	Forest Management Plan
FPA	Forest Practice Act
FRI	Fire Return Interval
FSC	Forest Stewardship Council
GDR	Green Diamond Resource Company study area
GDRC	Green Diamond Resource Company
ITP	Incidental Take Permit
ITS	Incidental Take Statement
JDSF	Jackson Demonstration State Forest
HCP	Habitat Conservation Plan
HFP	Habitat Fitness Potential

HCVF	High Conservation Value Forests
HUP	Hoopa Indian Reservation study area
HRC	Humboldt Redwood Company
LSA	Late-Successional Areas
LSAA	Lake or Streambed Alteration Agreement
LSR	Late-Successional Reserve
MBF	1,000 board-foot
MIS	Management Indicator Species
MMCA	Marbled Murrelet Conservation Areas
MRC	Mendocino Redwood Company
NCA	National Conservation Area
NCCP	Natural Community Conservation Plan
NIPF	Non-industrial private forest
NPS	National Park Service
NSO	Northern Spotted Owl
NTMP	Nonindustrial Timber Management Plans
NTO	Notice of Operations
NWC	Northwest California study area
NWFP	Northwest Forest Plan
ORV	Off Road Vehicle
PCB	Private Consulting Biologists
PFT	Pacific Forest Trust
PL	Pacific Lumber Company
PRNS	Point Reyes National Seashore
PSU	Primary Sampling Unit
REF	Suppressed reproduction and growth
RNSP	Redwood National and State Parks
ROD	Record of Decision
RPF	Registered Professional Foresters
SEIS	Supplemental Environmental Impact Statement
SHA	Safe Harbor Agreement
SOMP	Spotted Owl Management Plans
SOP	Spotted Owl Expert
SORP	Spotted Owl Resource Plan
SFI	Sustainable Forestry Initiative
SP	State Park
SPI	Sierra Pacific Industries
TCP	Timberland Conservation Planning Program
THP	Timber Harvest Plan
TPZ	Timber Production Zone
UCNRS	UC Natural Reserve System
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USFS	United States Forest Service
WCSA	Willow Creek Study Area
WLPZ	Watercourse and Lake Protection Zones

WNV	West Nile virus

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
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"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

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/phlylogeography 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 breath 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 (Lõhmus 2004). I noted in a comment box that you may update the demographic information as appropriate, but this reemphases 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 statues 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.

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 38:211–216.

Gutiérrez, R. J. 2008. Spotted Owl Research: a quarter century of contributions to education, ornithology, ecology, and wildlife management. Condor 110:792-798.

Lõhmus, A. 2004. Raptor habitat studies—the state of the art. Pp. 279–296. In Chancellor, R, D.; Meyburg, B.-U., eds. Raptors Worldwide. Proceedings of the 6th World Conference on Birds of Prey and Owls. Budapest, Hungary.

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
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
Arcata Fish and Wildlife Office
1655 Heindon Road
Arcata, CA 95521
707-822-7201 (phone)
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

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: 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

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, section2074.6, 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.

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.

> 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, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.

> 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 such migratory nongame bird except as provided by rules and regulations adopted by the Secretary of the Interior under provisions of the Migratory Treaty Act.

California Board of Forestry and Fire Protection

The California Board of Forestry and Fire Protection and the California Department of Forestry and Fire Protection (CAL FIRE) have designated Northern Spotted Owl as a “Sensitive Species” as identified in the California Forest Practice Rules (Cal. Code Regs., tit. 14, § 895 et seq.; hereafter Forest Practice Rules). These sections also define Northern Spotted Owl -related terminology, including “activity center”, “Northern Spotted Owl breeding season”, and “Northern Spotted Owl Evaluation Area.” Specific requirements for the disclosure of information on Northern Spotted 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 sections 919.9 and 919.10. Section 919.9 details the type of information about Northern Spotted Owl required in project documents submitted to CAL FIRE. This information is intended to be utilized by CAL FIRE to determine whether take of Northern Spotted Owl, in conjunction with timber harvest and related activities, would be avoided according to the criteria for determining take avoidance found in Section 919.10. Other 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 nests through buffers and avoidance of sensitive areas, while section 919.1 describes how snags will be retained. Section 919.16 details the protections afforded to late successional forests, which are a component of Northern Spotted Owl habitat.

International Union for Conservation of Nature

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

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, 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 km^2 (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 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 invasive 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).

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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 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/km^2) 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/ km^2 of habitat) at 0.544 owls/km^2 (95% CI = 0.495-0.592) and 0.660 owls/km^2 (95% CI = 0.601-0.719). Tanner and Gutiérrez (1995) estimated density in Redwood National Park, Humboldt County, to be 0.219 owls/km^2. 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/km^2±0.006, 0.351 owls/km2±0.011, and 0.313 owls/km^2±0.017 for Klamath, Korbel and Mad River regions respectively, with an overall mean density of 0.209 owls/km^2±0.009. Ecological density was 4.05, 2.99, and 1.86 times higher than crude densities for Klamath, Korbel, 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/km^2 in the northern portion of their land in Humboldt County, and 0.78 owls/km^2 in southern portions. Sierra Pacific Industry reported 0.450 owls/km^2 between 1989 and 2003 and between 2003 and 2007, and 0.459 owls/km^2 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/km^2 of area surveyed (MRC 2014). Lastly, Humboldt Redwood Company (HRC) reported 1.22 occupied territories/km^2 and 2.23 owls/km^2 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

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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.

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. 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 m^2/ha basal area (Irwin et al. 2013).

Home Range, Core Use Areas 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, Hunter et al. 1995).

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 Kernal, and Adaptive Kernal) 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 forest in the Klamath Mountains from 189 to 894 hectares (467 to 2209 acres), with little difference between breeding and nonbreeding seasons. The study showed core area size, annual home range and breeding home range size increased as amount of hard edge increased (Schilling et al. 2013). In their study site 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, with ranges being 3.5 times larger during the fall and winter months.

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, 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 (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 (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). Forsman et al. (2015) attributes the larger winter home range to prey dynamics and exploratory excursions in search of better habitat.

Like many other animals, Northern Spotted Owls exhibit selective behavior by utilizing certain areas with their home range more intensively than others (Bingham and Noon 1997). These areas of disproportionate use, termed core use areas, commonly include nest and roosting sites and access to dependable food sources. Bingham and Noon (1997) used breeding-season owl telemetry relocations and an adaptive kernel 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 is 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 Kernal, and AK = Adaptive Kernal.

Comment [JEH2]: Table may need editing in light of core use area data above.

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

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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

Dispersal

As discussed above, juveniles begin to disperse in the fall, with a few individuals beginning to disperse in early winter. Juvenile dispersal from the parental territory occurs in stages, as juveniles may temporarily settle in locations for up to 7 months before moving on to another temporary location, which may occur several times before individuals establish a territory of their own (Miller et al. 1997, Forsman et al. 2002). By late October, most young Northern Spotted Owls have dispersed from the natal area (Gutiérrez et al. 1985). LaHaye et al. (2001) found that successful juvenile California Spotted Owls often settled in territories previously used by pairs or single owls, which may suggest that owls were able to use some sort of cues that indicated some value of habitat quality when determining a territory of their own (Buchanan 2004).

In a study within Oregon and Washington, the median dispersal distance from fledging to a permanent 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 mi) for females (Forsman et al. 2002). Through band returns, dispersal distances for California Spotted Owls in southern California were determined to be 2.3 to 36.4 km (1.4-22.6 mi) for juvenile males, while juvenile females dispersed a distance of 0.4 to 35.7 km (0.2-2.2 mi) (LaHaye et al. 2001). While the only data available on dispersal pertains to Northern Spotted Owls in Washington and Oregon, and California Spotted Owls in California, we can extrapolate that Northern Spotted Owls in California act similarly, because, while the populations are genetically and geographically distinct, they still share many ecological and behavioral characteristics.

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

Habitat Requirements

Northern Spotted Owls have been found in a wide variety of forest types, including Douglas-fir, Western hemlock, grand fir, white fir, ponderosa pine, Shasta red fir, mixed evergreen and hardwood, and redwood forests (Forsman et al. 1984). Within the entire Northern Spotted Owl range, owls generally use older structurally complex forest types for nesting, roosting and foraging activities (Thomas et al. 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 an important habitat ~~components~~ feature (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. 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 Gutiérrez1990 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 Gutiérrez1999, 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."

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 (tress >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 foraging excursions, making descriptions of foraging habitat difficult to obtain compared to nesting and roosting habitat. Information on use and selection of foraging habitat is generally based on telemetry 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 diameter[1] 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 m^2/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.

[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.

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 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.

<u>California Coast Province</u>

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 then 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

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

<u>California Klamath Province</u>

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

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

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

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 DBH[1] >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 QMD[2] >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

			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	nesting-roosting habitat: for most locations average DBH >17 inches and average conifer canopy cover >60%; foraging habitat: in all locations average DBH >9.8 inches and average conifer canopy cover >40%, additional criteria in some locations

California Cascade Province

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

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

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

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

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

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

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

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

Habitat Effects on Survival and Reproduction

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

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 change[2]) 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

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

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 ≥40%, and overstory canopy coverage of ≥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).

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

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

[a]Size 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.

[b]Size 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.

[c]Franklin et al. (2000) differentiated only between "spotted owl habitat" as defined in the study and all other vegetation types.

[d]Edge 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.

[e]Franklin 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

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 m^2/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

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.

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.

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:

Comment [JEH6]: You may want to reword or reconsider this in light of my edits below.

> "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."

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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~~A~~ 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 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
Washington				
Cle Elum*	CLE	1989-2008	1,784	Mixed
Rainier	RAI	1992-2008	2,167	Mixed
Olympic*	OLY	1990-2008	2,230	Federal
Oregon				
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
California				
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.

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.

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 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.

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]
Washington				
Cle Elum	Declining	Declining	0.937	Declining
Rainier	Increasing	Declining	0.929	Declining
Olympic	Stable	Declining	0.957	Declining
Oregon				
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
California				
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

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

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

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

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

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.

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

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).

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.

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-

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).

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. 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~~ 2014 indicated that at least ~~58~~ 56 Barred Owl sites occurred within the parks, not including areas with single detections of Barred Owls. ~~In 2012~~During 2013-2014, four Northern Spotted Owls were detected at ~~just four territories~~three separate sites 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~~the last Northern Spotted Owl juvenile known to have been produced in the parks was in 2010 (Schmidt ~~2013~~2015). It appears that this Northern Spotted Owl population has been nearly extirpated in the parks, likely due to the rapid increase of Barred Owls (Schmidt 2015).

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In contrast to the above studies at demographic study areas and at other well-monitored areas that showed modeled declines in occupancy or displacement of Northern Spotted Owls from much of the 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 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.

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.

Source-Sink Dynamics

Pulliam (1988) was the landmark publication on source-sink population dynamics. Since then, 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 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
Modeling Regions			
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
Physiographic Provinces			
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

to the California Coast Range, California Cascades and Oregon Klamath provinces, with net flux most notable to the California Coast Range province.

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

CA Source Population Location	Ending Location	Percent Net Flux	$\Delta\lambda^R$
Modeling Regions			
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
Physiographic Provinces			
California Klamath	California Coast Range	100	47.4
	California Cascades	22.2	12.6
	Oregon Klamath	8.0	6.6

Schumaker et al. (2014) results suggest that California's population of Northern Spotted Owls is a significant component of and source to the range-wide population. As a source, the Klamath region populations provide a source of owls to sink populations on the Coast and Cascade ranges. This concept is central to protection of owl habitat, especially dispersal habitat, for the continued persistence of Northern Spotted Owls across their range.

Existing Management

Land Ownership Patterns in Northern Spotted Owl Range

The laws and regulations governing management of forests in the range of the Northern Spotted Owl vary depending on ownership. For this reason, the following discussion on existing management is partitioned based on ownership, with lands governed by a common set of regulations. In general, federal timberlands in the range of the Northern Spotted Owl are governed by the NWFP, with some 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 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-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)
Total	*24,465,790 (100)*

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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However, silviculture treatments (including thinning in stands less than 80 years old west of the Cascades and treatments to reduce the risk of large-scale disturbances) are allowed in LSRs to benefit the creation and maintenance of late-successional forest conditions. Timber harvest and salvage logging is allowed within managed LSAs to help prevent habitat destruction caused by large catastrophic events such as severe wildfires, disease, or insect epidemics. Congressionally reserved lands are those that were previously reserved by an act of Congress, such as Wilderness Areas, National Parks, and National Wildlife Refuges. Administratively withdrawn lands are areas identified in current forest and district plans as being withdrawn from timber production and include recreational and visual areas, back country, and other areas not scheduled for timber harvest. In California, reserved lands occur primarily in the interior portion of the Northern Spotted Owl range in the Klamath and Cascades provinces, with smaller amounts of reserved lands on the coast (Figure 11).

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

Comment [JEH12]: Unreserved lands includes riparian reserves, administratively withdrawn lands, and small reserved areas? Sounds like possibly incorrect, suggest you recheck this definition.

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

<u>Late Successional Reserves:</u>

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

- 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.

<u>Managed Late Successional Areas:</u>
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.

<u>Congressionally Reserved Lands:</u>
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).

<u>Administratively Withdrawn Areas:</u>
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.

<u>Riparian Reserves:</u>
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.

<u>Matrix Lands:</u>
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.

<u>Adaptive Management Areas:</u>
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 <u>noise-generating</u>~~heavy~~ equipment during the breeding season
- Retention of larger trees <u>in </u>owl nesting/roosting and foraging habitat

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

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

National Park Service

Redwood National and State Parks

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

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

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

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

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

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

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

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

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

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

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Point Reyes National Seashore and Muir Woods National Monument

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

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

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

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

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

- Treatment activities or any noise generation above ambient noise levels will not occur within 0.40 kilometer (0.25 mile) of a known occupied or previously used nest site, or within potential Spotted Owl habitat between February 1 and July 31 (breeding season), or until such date as surveys conforming to accepted protocol have determined that the site is unoccupied or non-nesting or nest failure is confirmed.
- Mechanical fuel reduction activities in suitable habitat, known or potential, will not substantially alter the percent cover of canopy overstory and will preserve multilayered structure. When shaded fuel break features in suitable habitat are constructed, the resulting multilayered canopy will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency vehicle clearance.

- Prior to fire management activities, project areas will be surveyed for the presence of dusky footed woodrat nests. If feasible, woodrat nests will be protected.
- Within habitat, the cutting of native trees greater than 10 inches DBH will be avoided unless a determination is made that the native tree presents a clear hazard in the event of a fire or cutting is the only option to reduce high fuel loading.
- The fire management officer will arrange for qualified biologists to conduct post-project monitoring to determine short- and long-term effects of fire management actions on activity centers if resources are available.

Tribal Lands

Hoopa Valley Indian Reservation

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

The Hoopa Valley Indian Reservation is expected to function as a high quality corridor between late successional reserves to the north, south, and east, and Redwood National Park to the northwest. The reservation will retain sufficient habitat for 50 potential Northern Spotted Owl territories and 20-40 pairs of owls at all times during the planning period. However, the plan notes this number of Northern Spotted Owl will not likely be realized unless Barred Owls are removed from the reserve. Between 2009 and 2014 over 85% of the historic Northern Spotted Owl sites within the reservation had Barred Owl detections during regular surveys, with a steady decline in Northern Spotted Owl occupancy beginning in 2007 in concert with an ongoing increase in Barred Owl detections (Higley 2012).

Eight forested management units noted in the FMP will retain Northern Spotted Owl dispersal habitat. None of the forested management units will dip below 50% cover of dispersal or higher quality habitat. The lowest level of owl habitat retention will occur within the Hopkins management unit, which at 72%

at the time of the publication of the FMP, was projected to drop to 64% in 2012 and increase to 81% by 2026.

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

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

Yurok Indian Reservation

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

The Yurok Tribe's FMP (Yurok Forestry Department 2012) includes elements for the management of all Yurok Tribal lands both within and outside of the reservation boundary. The FMP calls for ~~intensive~~ surveys for Threatened and Endangered (T&E) species (including Northern Spotted Owl) and then dedication of no cut areas around all T&E species sites and most traditional species nest/roost/den sites. The management objective for Northern Spotted Owl is to maintain all activity centers as no harvest reserves for the benefit of late-seral cultural, sensitive, and listed species. Northern Spotted Owl activity centers protect owl roost/nest sites and are a minimum of 60 acres of the best existing Spotted Owl habitat as determined by a qualified wildlife biologist. Seasonal restrictions may be required on disturbance activities within 0.25 mile of Northern Spotted Owl nest.

Round Valley Indian Reservation

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

Nonfederal Land

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

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

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

A Timber Harvesting Plan (THP) is generally the environmental review document submitted by landowners to CAL FIRE which outlines the timber to be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment. THPs are prepared by Registered Professional Foresters (RPF) following the provisions of the Forest Practice Rules. The THP process substitutes for the Environmental Impact Report (EIR) process under CEQA because the timber harvesting regulatory program has been certified pursuant to Public Resource Code section 21080.5.

In early 1990, the Department began preparation for a possible Northern Spotted Owl listing decision by the USFWS by selecting and training 13 Department biologists in owl biology and ecology. These biologists would become the first “designated biologists” who would consult on proposed THPs.

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Concurrently, the BOF worked with CAL FIRE, USFWS and the Department to design emergency rules and procedures that would be adopted in the event of listing. The rules identified descriptions of Northern Spotted Owl habitat, requirements for surveys and consultations, and standard measures for timber operations to avoid take. The rules called for consultations between plan proponents and Department designated biologists. The USFWS worked with BOF and CAL FIRE staffs and others to amend the initially adopted emergency rules; amendments to the rules occurred several times as knowledge of the Northern Spotted Owl increased and with experience gained through implementation of the consultation process. The BOF ultimately adopted Forest Practice Rules sections 919.9 [939.9] and 919.10 [939.10] in March 1991, 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.

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

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

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

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

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

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

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

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

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

Breeding season disturbance buffers and Northern Spotted Owl habitat retention requirements were provided by the USFWS in the 1991 survey protocol, but these were actively refined during the following 12 months. The protocol identified the timing of surveys, number of visits, key owl behaviors that could inform a status determination, and revisit criteria. After being finalized in 1992, the survey protocol, breeding season disturbance buffer and habitat retention requirements remained unchanged for nearly 18 years except for those approved under Habitat Conservation Plans, Spotted Owl Management Plans and Spotted Owl Resource Plans. In 2011, and again in 2012, the Northern Spotted Owl survey protocol was revised (USFWS 2012).

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

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

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

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

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

- Other emerging and compelling forestry sector conservation issues required Department staff’s attention (e.g., the impending listings of Coho Salmon under ESA and CESA, HCP-related workload).
- The Department “Timber Harvest Assessment Program” (later to become the “Timberland Conservation Planning Program”) budget did not include funding specifically for consultations.
- Staffing of USFWS offices with wildlife biologists had increased.
- The Department felt CAL FIRE and USFWS staff were capable of review, approval, and assessment of THPs and NTMPs.
- The PCB mechanism for processing Northern Spotted Owl consultations appeared successful.
- The scope, quality and conformance of owl-related information with Forest Practice Rules requirements appeared to have stabilized after approximately six years of implementation.

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

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

In 2009, the USFWS developed a white paper, Regulatory and Scientific Basis for the U.S. Fish and Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in California's Northern Interior Region, to scientifically justify why the 2008 guidance deviated from the Forest Practice Rules (USFWS 2009). The white paper recommended using a circular 0.5 mile area around activity centers as the core use area for habitat assessment and management purposes. Specific criteria within the USFWS guidelines, and how they differ from the Forest Practice Rules, are discussed in the Timber Harvest section below.

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

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

13 THPs from Interior Counties	Acres	62 THPs from Coastal Counties	Acres
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 habitat retention in the northern interior region of California (USFWS 2009), which differ somewhat from Forest Practice Rules guidelines.

Forest Practice Rules guidelines under Option (g) are:

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

The USFWS (2009) recommendations are:

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

As noted previously, six interior THPs and 60 coastal THPs associated with a total of 146 Northern Spotted Owl activity centers (14 interior activity centers, and 132 coastal activity centers) utilized Option (e) 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 six interior THPs, four primary habitat types were assessed: low quality foraging, foraging, nesting/roosting, and high quality nesting/roosting as defined in recommendations by the USFWS (2009). Each of the 60 coastal THPs that utilized Option (e) included a pre- and post-harvest habitat analysis for each owl activity center within 0.7 mile of a given THP. For these, three primary habitat types were assessed: foraging, nesting/roosting, and non-habitat.

Table 13 summarizes proposed acres of owl habitat retention within the interior and coastal regions for THPs utilizing Option (e). Total acreages presented are cumulative acres for six THPs within the interior, and 60 THPs within the coast. Foraging habitat was the most common habitat type retained in the interior (2,117 acres within 0.5 miles and 9,776 acres within 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; 47,344 acres of nesting and roosting).

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).

	6 Interior THPs associated with 14 activity centers, Option (e)		60 Coastal THPs associated with 132 activity centers, Option (e)
	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

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).

	7 Interior THPs associated with 8 activity centers, Option (g)		2 Coastal THPs associated with 6 activity centers, Option (g)
	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

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 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.

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.

		Interior, Option (e) Acres harvested		**Interior, Option (g) Acres harvested**	
Activity Center	**Range of Harvest Years**	**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

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

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

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

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

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.

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

Table 17. Summary of NTMPs in Siskiyou, Trinity, Shasta, and Tehama counties for years 1991-2014, and years 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**
Interior Counties 1991-2014					
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
Coastal Counties 2005-2014					
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**

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

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**
Interior Counties 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
Coastal Counties 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**

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

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

The variability in methods used adds to uncertainty of this analysis as it relates to Northern Spotted Owl habitat modification or retention within NTMPs. While conducting the NTMP analysis, it became clear that some information was not available to the reviewer due to the nature of the older NTMP narratives, limited public information, and subsequent amendment submissions. There is simply no effective way to track this information in an analysis going back in time. Though Selection and Group Selection silvicultural methods were most used among NTMPs within the Northern Spotted Owl range, we can infer that owl habitat is retained to some extent; however, we could not 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.

<u>Spotted Owl Management Plans</u>

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

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

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

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

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

Spotted Owl Resource Plans

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

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

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

Habitat Conservation Plans

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

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/mi^2 and 0.32 owls/mi^2, 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

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

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

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

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

According to Diller et al. (2012), GDRC's original 1992 HCP was developed when comparatively little was happening in the way of Northern Spotted Owl research along the coastal forest, and consequently the

understanding of suitable owl habitat was limited. In 2006, GDRC submitted an application to the USFWS to amend its 1992 Incidental Take Permit (ITP), and in December 2007, the amended ITP was issued (USFWS 2007). Also in 2007 the USFWS issued an internal biological opinion (BO) which describes the Project, requires the Applicant to comply with terms of the amended BO and its associated incidental take statement (ITS), and incorporates additional measures. In December 2013, GDRC notified the Department that the BO was issued and requested that the Department issue a consistency determination (CD) that the HCP is consistent with CESA pursuant to Fish & Game Code section 2080.1. In January 2014, the Department found that BO, 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-Iisted species (CDFW 2014a).

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

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

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~~ 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.

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

Northern Spotted Owl management objective outlined in the plan include:

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.

Northern Spotted Owl conservation measures outlined in the plan include:

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.
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.
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 31site 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.
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.

Characteristics of suitable nesting habitat, if present, must be maintained within 500 feet of the activity center. Within 500 to 1,000 feet of the activity center, characteristics of suitable roosting habitat, if present, must be retained. Within 0.7 mile of the activity center 500 acres of suitable owl habitat must be provided, if present, and less than 50 percent of this shall be under operation in any one year. If present, 1,336 total acres of suitable owl habitat must be provided, within 1.3 miles of each activity center.

5. Designate additional owl activity sites as “Level Two” habitat retention sites by September 1 of each year to make up the minimum number of activity centers designated by the HCP. “Level Two” habitat retention must 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. Following the breeding season, 18 acres around the AC shall be maintained as suitable nesting habitat, if present, and a 400 ft radius buffer protecting the AC must the in place. For sites, which have been determined to be occupied by a non-nesting pair or single, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and a 400 foot radius buffer protecting the activity center must the in place. Harvesting of these sites may occur during the breeding season, in the area adjoining the 18-acre habitat retention area.

6. Activity center that are not needed to meet management objectives above shall receive “Level Three” protection measures. These activity centers shall have a 1,000-foot buffer during the breeding season. Timber harvest associated may occur before March 1 or after August 31. During the breeding season, for activity centers which have been determined to be occupied by a non-nesting pair or single owl, 18 acres around the activity center shall be maintained as suitable nesting habitat, if present, and have a 400 foot radius buffer. Harvesting may occur during the breeding season in the area adjoining the 18-acre habitat retention area.

7. All nest trees shall be marked and be retained if the activity center is harvested.

The HCP outlines an objective to conserve habitat diversity and structural components within the plan area that would benefit Northern Spotted Owls. The objective will ensure that a mix of vegetation types and seral stages are maintained across the landscape over the permit period, as well as structural components, to contribute to the maintenance of wildlife species covered under the plan, including the Northern Spotted Owl.

Structural components to be retained include:

1. A certain number and size snags that do not pose a human safety hazard.

2. A certain number and size of green replacement trees, if snags are not present, with a priority for trees other than redwood.

3. At least four live cull trees per acre of Class I and II Riparian Management Zones, with a priority given to trees 30 inches DBH and trees with visible defects such as broken tops, deformities, or cavities.

4. All live hardwood trees over 30 inches DBH that do not constitute a safety hazard, to a maximum of two per acre.

5. Two logs per acre greater than 15 inches in diameter and over 20 feet long, with priority given to logs over 30 inches in diameter.

In February 2014, HRC notified the Department that a BO was issued by the USFWS and requested that the Department issue a CD that the HCP is consistent with CESA pursuant to Fish & G. Code section 2080.1. In February 2014, the Department found that BO and its related ITS and ITP, and the HCP are in fact 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 2014b).

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

- Sell the Headwaters Forest, Owl Creek Reserve, and Grizzly Creek Reserve to the state and federal governments to ensure their functions as wildlife reserves in perpetuity.
- Set aside, for the life of the HCP, some of the most valuable owl and marbled murrelet nesting habitat in a series of Marbled Murrelet Conservation Areas (MMCAs).
- Conduct a combination of night and daytime surveys and stand searches to locate both known, and any new, owl activity centers.
- Comply with the Northern Spotted Owl Conservation Strategy, which relies upon other conservation elements of the HCP for the retention and recruitment of potential foraging, roosting, and nesting habitat in watersheds across the ownership throughout the HCP period.
- Maintain a minimum of 108 activity centers each year over the life of the HCP.
- 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.
- Conduct complete annual censuses to monitor all activity centers on the ownership and to determine numbers of pairs, nesting pairs, and reproductive rates.
- Survey the THP area and a 1,000-foot buffer for new operations, except site preparation, initiated in the period beginning February 21 and ending on or before August 31.
- Starting in 2014, and at five year intervals thereafter, conduct an analysis of owl occupancy and detection probabilities using accumulated survey data.
- Submit annual reports describing the activities undertaken, results of the Operating Conservation Program, and the proposed Operating Conservation Program activities for the next year for all lands covered by the HCP.

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

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

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

The Mendocino Redwood Company (MRC) is in the process of developing a HCP and NCCP with the federal and state agencies. ~~Once~~ If the permit is issued, the term ~~will~~ would be 80 years. The HCP/NCCP will determine how MRC manages threatened and endangered species, rare plants, and natural communities on their land ownership in Mendocino ~~and Sonoma~~ counties. The Northern Spotted Owl will be a covered species in the plan. Coverage is proposed for 203,940 acres of a~~A~~pproximately 228,800 acres of coast redwood and Douglas-fir forests ~~exist on~~ that comprise the total MRC land ownership, which ~~and~~ is located within the California Coast Province. Up to date progress on the HCP/NCCP development can be found on the MRC website (http://www.mrc.com).

Terra Springs LLC HCP

The Terra Springs HCP has been designated as a "Low Effect HCP" due to its limited effects on the Northern Spotted Owl and owl habitat (Butler and Wooster 2003). This HCP covers 76 acres in Napa County west of the city of St. Helena, and is located within the California Coast Province. The plan has a 30 year term that expires March 3, 2034. The plan covers conversion of 22 acres of mature (80-120 year old) Douglas-fir forest to vineyard, as well as any removal of trees from the remainder of the covered lands. One Northern Spotted Owl activity center is associated with the plan is located 1.1 miles from the covered lands. Owl habitat within the activity center (large redwood and Douglas-fir trees) is surrounded by vineyards, orchards, grazing lands, and rural residences. The objectives of this low-effect HCP are to maintain 41 acres of suitable roosting and foraging habitat within the covered lands in perpetuity while accomplishing the economic objectives. Measures set for the plan include: (1) Retention of nesting, roosting and foraging (41 acres total); (2) Deed a restriction placed on these 41 acres to provide for their management as owl habitat, in perpetuity; (3) Habitat modification limited to removal of small trees, felling hazardous trees, create slash piles for prey habitat, selection of appropriate silviculture practices, retention of 60-75% canopy closure throughout the entire operating area, retention of non-hazardous 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 federal and private lands have shown that many activity centers are located on or have a home range that extends onto the FGS ownership.

Safe Harbor Agreements

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

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

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

Forster-Gill, Inc., Safe Harbor Agreement

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

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

- Maintain 216 acres at the WHR 4D-level averaged over a 54 acre polygon.
- Retain all snags not posing a hazard risk.
- Conduct annual owl surveys on property and within a 500 foot radius around the property.
- Ensure additional nest sites found are protected by a 300 foot no-cut-buffer.
- Ensure no harvest occurs within 1,000 ft of any active owls nest site.
- Ensure harvest conducted between 300 and 500 foot from active owl nest sites be under single tree selection, retains 80 percent canopy closure of trees at least 12 in DBH, and is reviewed and approved by USFWS.
- Conduct timber stand inventories and provide USFWS with data.

- Allow USFWS or other agreed-upon party access to property for monitoring and management activities.

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 a roosting ~~single and~~ pair~~s~~ ~~were~~was located on Lindsay Creek.

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. The lands enrolled in this SHA are also currently managed under a NTMP.

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, and nesting/roosting habitat will be expanded and maintained to 1,947 acres (90% of area) for the remainder of the permit term. 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 the following protection measures for up to five activity centers, any additional activity centers on covered lands may be managed in a manner that results in take. A 300 foot no harvest buffer will be maintained around no more than two activity centers, and a 100 foot no harvest buffer and a 100 to 300 foot partial harvest buffer will be maintained around no more than three activities. The activity center currently existing at van Eck and one additional future activity center will receive the 300 foot no harvest buffer (6.5 acres) around their 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~~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

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

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

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

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

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

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

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

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

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

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

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

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

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

EXTERNAL PEER REVIEW DRAFT – DO NOT DISTRIBUTE: September 8, 2015

The Protection of Habitable Structures Exemption was adopted in 2015 by the Board of Forestry due to the prolonged drought and allows trees to be cut and removed that are located 150 feet up to 300 feet from any point of an habitable structure that complies with California Building Code for the purpose of reducing flammable materials and maintaining a fuel break. The post-harvest stand shall be primarily comprised of healthy and vigorous dominant and co-dominant trees well distributed throughout the treated area and meet the stocking standards consistent with Forest Practice Rules sections 913.2, 933.2, 953.2. The quadratic mean diameter of trees greater than eight inches in the pre-harvest project area shall be increased in the post-harvest stand.

During the time in which the Northern Spotted Owl has been listed as threatened by the USFWS, approximately 41,767,250 acres (1992 to 2013) have been exempted for harvest in counties within the 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.

<u>Emergency Harvest</u>

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.
- Fallen, damaged, dead, or dying trees as a result of wind, snow, freezing weather, fire, flood, landslide, or earthquake.
- Dead or dying trees as a result of air or water pollution.
- Cutting or removing trees required for emergency construction or repair of roads.
- Cutting and removal of hazardous fuels.
- Treatments to eradicate an infestation of Sudden Oak Death.

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

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

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

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

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

<u>Other Management Actions</u>

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.

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. Second-growth forests are managed through silvicultural methods (thinning, replanting, and burning) to reduce the time needed to attain a mature forest. Additionally, conifer encroachment into oak woodlands and prairies is managed through tree removal and burning. Nine management zones within the RNSP delineate the degree of human influence and development on that can occur on the landscape (NPS 2000a).

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

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

University of California Natural Reserves

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

Department Ecological Reserves

Authorized by the California Legislature in 1968 and administered by the Department, the ecological reserve system is designed to conserve areas for the protection of rare plants, animals, and habitats, and to provide areas for education and scientific research. The system now encompasses 119 properties totaling nearly 129,000 acres. Sixteen Department Ecological Reserves (totaling 16,753 acres) occur within the range of the Northern Spotted Owl; however there are no management plans for the system or individual reserves and the status of Northern Spotted Owl on these lands is unknown. One exception is the Headwaters Forest Ecological Reserve, a 7,515 acre Department Conservation Easement owned by BLM, which manages for late seral habitat benefiting Spotted Owls.

Fisheries Restoration Grant Program

As part of the Fisheries Restoration Grant Program (FRGP), certain measures for protection of Northern Spotted Owls and their habitat are required for each project funded. The purpose of FGRP is to support restoration projects along watersheds to enhance salmon and steelhead habitat. Applicants must 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)

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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 large areas of coastal and low lying areas that no longer support suitable nesting and roosting habitat (see Figure 4).

Comment [JEH15]: But you define historical as pre-logging. Need to clean this up.

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

Assessing Habitat Loss through Implementation of the Northwest Forest Plan

The Northern Spotted Owl was listed under the federal Endangered Species Act in 1990 in part because of widespread loss of Spotted Owl habitat across the range of the subspecies (USFWS 1990). The revised recovery plan lists the most important threats to the Spotted Owl as competition with Barred Owls, ongoing loss of Spotted Owl habitat as a result of timber harvest, habitat loss or degradation from stand replacing wildfire and other disturbances, and loss of amount and distribution of Spotted Owl habitat as a result of past activities and disturbances (USFWS 2011a). To address ongoing decline of Northern Spotted Owl habitat across the range, the NWFP established reserved lands including late-seral reserves, adaptive management reserves, congressionally reserved lands, managed late-successional areas, and larger blocks of administratively withdrawn lands (USDA and USDI 1994) (Figure 11). These are described in more detail above. It was assumed that habitat in reserves would improve over time as successional processes led to more mature forests, however, this is a slow process and so recruitment of habitat conditions on reserves was expected to take many decades. It was also assumed that habitat outside of reserves would continue to decline due to timber harvest and other disturbances but that dispersal habitat would be maintained in order to facilitate movement between reserve lands. Given the continued Northern Spotted Owl population declines and the increasing threat of the Barred Owl, the revised recovery plan recommended conserving occupied sites and unoccupied, high-value Spotted Owl habitat on state and private lands wherever possible (USFWS 2011a).

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

Although federal lands contain less than half of the total forest land within the entire range of the Northern Spotted Owl (Mouer et al. 2011), 71% of the remaining Northern Spotted Owl nesting and roosting habitat occurs on federally administered lands (Davis et al. 2011). Rangewide, nesting and roosting habitat loss was estimated at 7.3%, with 3.4% (about 298,600 acres) of habitat on federal lands lost and 15.5% (about 649,300 acres) of habitat on nonfederal lands lost (Davis et al. 2011). On federal lands, most of the nesting and roosting habitat loss was due to wildfire and other natural disturbance (about 244,800 acres; 2.8% of nesting and roosting habitat on federal lands), and more habitat was lost on reserve lands than on nonreserved lands (Figure 16). This pattern is likely in part attributable to the fact that federal land is predominately distributed in the drier portions of the Northern Spotted Owl range (Healey et al. 2008). The rate of Northern Spotted Owl habitat loss due to harvest on federal lands has declined since the listing of the species in 1990 and the implementation of the NWFP in 1994. Only 0.6% of nesting and roosting habitat on federal lands was lost to harvest, most of which occurred on nonreserved lands.

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

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

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

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

Comment [JEH16]: Identical to the definition in Thomas et al.? Check.

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 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 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 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 utilizing 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 the level of information available, particularly older plans, was limited in some cases. Considering 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 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 suppress~~ing~~ 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.

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

As discussed in the Habitat Requirements section of this report, 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; Franklin et al. 2000). See the Habitat Effects on Survival and Reproduction section of this report for a discussion of HFP and additional studies that have contributed to an understanding of habitat characteristics that provide high HFP. The studies that have evaluated HFP at the territory scale have varied somewhat on the extent or distribution of habitat types that provide high quality territories, but consistent trends and relatively narrow ranges of habitat extent and configuration allow for an evaluation of the impact of management on Spotted Owl habitat.

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

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The USFWS recently expressed concern that habitat parameters and retention criteria, as defined by the Forest Practice Rules, may create the illusion of adequate suitable habitat retention, but in reality owls may be forced to use low quality habitat thereby lowering overall fitness (USFWS 2009). An analysis conducted by the USFWS (2009) compared territory loss on private timber lands to USFS lands from 1978-2007 to elucidate the potential insufficiency of the Forest Practice Rules in preventing owl territory loss. They found on private timber lands there was a 54% decline in pair status to no response, and a 23% decline from pair status to single owl status, whereas on USFS lands 80% of the sites did not change pair status. A lack of owl responses and a lack of suitable habitat to support continued occupancy and survival was noted in USFWS technical assistance letters issued regarding THPs and NTMPs in the early 2000s (USFWS 2009). Because of these concerns and the growing body of literature linking habitat characteristics to owl fitness, the USFWS asserted that the Forest Practice Rules were insufficient to 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.

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).

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			

[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.

Table 22. 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 interior region of 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.

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 form 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

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

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 mi^2) 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

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~~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, 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; much uncertainty remains on the effect of wildfires on the extent and quality of Spotted Owl habitat. Results of studies on the effect of fire on occupancy rates by Spotted Owls have 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 and from southwestern Oregon in the range of the Northern Spotted Owl, 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 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 ≥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).

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

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

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

<u>Historical Fire Regime in the Klamath Province</u>

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 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.

<u>Historical Fire Regime in the Cascades Province</u>

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 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.

<u>Recent Changes in Fire Regimes and Possible Causes</u>

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 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

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).

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

Several studies have determined a strong link between changes in fire extent, severity and season, with low precipitation and high temperatures. In addition to land-use history over the last century, climate 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.

<u>Role of Fire Regimes in Influencing Forest Structure and Spotted Owl Habitat</u>

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 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).

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).

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 ~~that~~ 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. McIntrye 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. 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 120,000km^2 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 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 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

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. 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 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, Barrows 1981), 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 as platform-style nests with little to no overhead cover or side walls, were found to be less effective at protecting eggs from heat loss. These results support that optimal nesting habitat for Spotted Owls must include structurally complexity to provide nesting options with proper protection. The intensity of disturbance will likely play a role in whether or not any particular disturbance event will be beneficial or detrimental to owl habitat complexity. For example, forest complexity may be significantly reduced when large catastrophic wildfires completely eliminate large tracts of forest; while small-scale fires may increase the level of structural complexity.

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

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

Comment [JEH18]: Not sure that direct mortality from fire has ever actually been documented.

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

Temperature within the range of the Northern Spotted Owl was assessed for summer months (June-August) and winter months (December-February) separately. Comparing the 30-year average with the 5-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 sever 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, Barrowclaugh 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.

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 1,970[3] 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.

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, 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;

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 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 a. 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 were268 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).

When Barred Owls were removed from territories previously occupied by Northern Spotted owls, within 13 to 152 days Spotted Owls were again detected. Through band returns, it was demonstrated that some sites were reoccupied by the same Spotted Owl pair that was associated with the site prior to Barred Owl occupancy, while others were colonized by new pairs after the Barred Owls were removed (Diller 2012).

During the winter of 2013/2014, experimental Barred Owl Removal was conducted at Hoopa Valley Indian Reservation. A total of 71 Barred Owls were removed (78% of all Barred Owls detected, 97% adutls, 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.

Comment [JEH20]: I am fairly certain that Hoopa has documented some positive effects of removal on spotted owls, contact Mark Higley at Hoopa.

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 at 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 (Gutiérrezet 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).

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 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 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 Hippoboscid flies on 62 of the 382 Northern Spotted Owls captured over five years between April and September, with higher prevalence in adults that 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 Hippoboscid 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 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 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 bromadiolone) 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 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.

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.

Sudden Oak Death Syndrome

Sudden oak death is caused by a non-native, fungus-like pathogen (*Phytopthora 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. *Phytopthora 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.

Once sudden oak death infection is confirmed in an area, survival of susceptible species decreases quickly. Cobb et al. (2009) examined mortality caused by sudden oak death within coastal redwood forests from Sonoma to Monterey counties. 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. 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. The study found that live oak and tanoak survival declined as a function of disease state. Coast live oak survival was 11.7 to 15.8 years for asymptomatic trees; 7.5 to 11.7 years for trees 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).

After a susceptible tree is infected with sudden oak death fungi, secondary infection from other fungi and insects is common and impacts survival times. 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. 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 (m^2/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).

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). Hardwood trees within conifer stands are not only important structural components within stands of suitable spotted owl habitat, but they also provide cover and food resources for ~~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 course 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 (Tempel 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 course 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). In addition, mortality from sudden oak death, or the treatment of sudden oak death outbreaks, may exacerbate problems associated with fuel accumulation and wildfire suppression (Valachovic et al. 2011).

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,

> "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 increased contact vocalizations, decreased prey handling at the nest, decreased daytime maintenance with the presence of hikers (Swarthout and Steidl 2003).

It is clear recreational activities (e.g., hiking, roads, and motorcyles) impact owls to some extent, but the level to which these activities may impact owl behavior, reproduction and overall survival 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

There had previously 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 provides compelling evidence that a population bottleneck may have occurred within the last few decades (Funk et al. 2010). The study collected blood samples from 352 Northern Spotted Owls from six regions across the range which included limited samples from the northern portion of the California Klamath Province.

> Funk et al. (2010) found the most significant evidence for recent (i.e., last several decades) bottlenecks in the portion of the range inclusive of the Washington Cascades, and no significant evidence of bottlenecks were found in the Olympics, Oregon Cascades, and Northwest California. The authors cautioned that genetic bottlenecks, while indicating a decrease in genetic variation and hence effective population size, do not necessarily indicate a decline in actual (demographic) population size (Funk et al. 2010) "… it is important to keep in mind that reductions in [effective population size] (detected with bottleneck tests) are different than reductions in demographic population size (detected with demographic field studies) and reductions in one of these parameters does not necessarily result in a change in the other." (Funk et al. 2010)

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 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.

<u>California Forest Practice Rules</u>

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 surrounding the activity center (500 and 1,000 foot radii), the core use area (0.7 mile radius), and the broader home range (1.3 mile radius).

The most recent research on Northern Spotted Owl habitat requirements in California and southern Oregon have demonstrated a link between owl fitness and the amount of types of habitat, structural characteristics, and spatial configuration in a home range. This requirement for habitat heterogeneity is consistent with the general approach incorporated in the Forest Practice Rules. Although study design has varied across the major research studies, some consistent patterns have arisen. In order to support productive Spotted Owl territories, a minimum amount of older forest must be retained in the core area. The definition of ‘older forest’ evaluated in studies has varied, but consistently includes late-seral forests with large trees and high canopy cover. Productive territories generally had at least 25-40% older forest in an approximately 400 acre core area.

Another consistent finding suggests that large amounts of nonhabitat (defined as nonforest or sapling cover types) in a Northern Spotted Owl home range leads to declines in demographic rates and fitness. Results indicate that in order to support a productive Northern Spotted Owl territory, no more than about 50% of a home range should consist of nonhabitat.

The USFWS used the results of the latest research on Spotted Owl habitat to update recommendations for habitat retention in order to avoid take, and asserted that the minimum requirements in the Forest Practice Rules were insufficient to adequately avoid take of Northern Spotted Owls. The total acreage of recommended retention in the USFWS guidance does not differ from that found in the Forest Practice Rules, and is consistent with research indicating that about half of a Northern Spotted Owl home range must be retained in habitat. However, based on assessment of core use areas in the interior portion of the range, the USFW modified the retention of habitat in core use are to occur within 0.5 miles of an activity center, instead of the 0.7 mile radius in Forest Practice Rules. This brings the recommendations in line with core use areas evaluated in recent work. The most significant change in the revised USFWS recommendations was in the definitions of nesting, roosting, and foraging habitat and in the specific amount of each type to be retained. Although the types of forests used by Northern Spotted Owl for nesting, roosting, and foraging does vary, the USFWS requirement for the oldest forests to be retained near the core is consistent with the literature.

A comparison of the habitat definitions in the Forest Practice Rules (see Appendix 2) and the revised USFWS recommendations (see Table 22 for the interior portion of range in California) shows large discrepancies in the definition of habitat that meets nesting and roosting habitat requirements. Under the Forest Practice Rules minimum retention requirements and habitat definitions, stands that meet the USFWS definition for nesting or roosting habitat are retained only within 500 feet of a nest (~18 acres). This is an inadequate amount of nesting habitat to support productive owls. The remainder of the 500 acres 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 under Forest Practice Rules, a definition that is considered low quality foraging habitat by the USFWS; therefore there is no requirement in the Forest Practice Rules for this habitat include nesting or roosting habitat under the Forest Practice Rules.

Our assessment of selected activity centers shows that the habitat retention guidance in the Forest Practice Rules are not always met, indicating that harvest is impacting Northern Spotted Owl at some locations. Of the activity centers evaluated, several experienced very high acreages of harvest at both the broad home range and in the core area, which would have resulted in territories that do not meet the USFWS recommendation for take avoidance, and would have resulted in declines in survival and fitness of the local owls.

Documentation of habitat type, amount, and distribution present around activity centers after THPs are implemented is poor, so it is difficult to broadly assess the degree to which THPs have met either the Forest Practice Rules or the USFWS recommendations for habitat retention. As shown above, even if minimum retention requirements in the Forest Practice Rules are implemented as written, there is still the potential for degradation of Northern Spotted Owl habitat at activity centers. The demonstrated failure in some cases to implement the habitat retention in the Forest Practice Rules reveals impacts that have occurred in recent years.

The THP review and post-harvest follow-up process should ensure that the best scientific information is being considered to avoid take of Northern Spotted Owl at known territories. Although the degree to which this has occurred in recent years is difficult to ascertain, our assessment of proposed harvest at a sample of activity centers indicates that it is not universally applied and that insufficient habitat has been retained to avoid impacts to Northern Spotted Owls. Without changes to this process the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

<u>Salvage Logging</u>

Several variables complicate the interpretation of owl response to fire, including variation in fire severity, fire size, fire history and pre-fire forest composition, post-fire salvage logging, and the timing and duration of research post-fire. Regardless, several studies 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. Although hampered by small sample size, incidental observations have documented declines in occupancy of burned areas following salvage logging. Modeling of occupancy at burn sites has also shown an effect of salvage logging on extinction probabilities, although the impacts of salvage logging were observed only in combination with other factors.

The presence of snags has been suggested as an important component of prey habitat and as perch sites for foraging spotted owls. Conditions that lead to increased prey availability, including increased shrub and herbaceous cover and number of snags, may be impacted by salvage logging.

Post-fire salvage logging may be contributing to the loss of suitable habitat beyond the loss due to the fire itself, by removing important structural elements and removing important prey habitat. The available information suggests that salvage logging reduces the probability that spotted owls will use burned areas and has resulted in declines in occupancy, either through abandonment or declines in survival.

Wildfire

Wildfire and other natural disturbance has been the leading cause of habitat loss on federal land and wildfire has been the second leading cause of nesting and roosting habitat loss in California since 1994, after timber harvest. Since 1994, 4.2% of nesting and roosting habitat on federal lands has been lost to wildfire, and most of this loss has occurred in the Klamath Province.

The response of Spotted Owls to fire has been mixed. In some cases, Spotted Owl has been shown to use burned areas extensively, although nesting and roosting general occurred only in unburned or low-severity burn areas. In these cases, foraging occurred across burn severity types. Occupancy by California Spotted Owl across a wide area in the Sierra Nevada has been observed to be similar in burned and unburned areas, at least at burn areas that experienced mixed-severity burns. There is some evidence that high severity burns in the Sierra Nevada have resulted in declines in occupancy.

Conversely, Northern Spotted Owls in southern Oregon were shown to have declines in occupancy following fire. These declines resulted from both high extinction rates in burned areas and low colonization rates.

Northern Spotted Owls displaced by fire or occupying burned areas post-fire have also been shown to experience declines in survival. Food limitation in burned areas may have been a factor in declining survival rates. These observed declines in southern Oregon may be confounded by the occurrence of post-fire salvage logging. An observational study on a total of 11 territories from all three Spotted Owl subspecies from California, Arizona, and Mexico did not indicate a decline in survival of resident owls in the year following fire; these owls were not tracked to investigate potential longer-term effects.

Northern Spotted Owls in southern Oregon were also shown to avoid large areas of high severity burn or areas experiencing extensive salvage logging post-fire, but selected areas with small scale disturbance for foraging.

The available information suggests that wildfires can have positive effects on Northern Spotted Owls when they burn at mixed severities or at a small scale that can provide habitat heterogeneity without removing important nesting and roosting habitat components at the territory scale. However, uncharacteristically severe fires that burn at large scales likely have negative effects by eliminating required habitat at Northern Spotted Owl territories. Additional studies over long durations are needed in order to inform the degree to which fire affects Spotted Owl, and the degree to which fire may be used as a management tool.

Historical fire regimes in the range of the Northern Spotted Owl in the dry provinces of California included mixed-severity fire that resulted in a heterogeneous post-fire landscape. In recent decades, fires have become more frequent and average fire size has increased. In some cases fires have also burnt at uncharacteristically high severities, especially during weather conditions that support fire (dry and hot conditions). Because climate change will likely increase the likelihood of conditions that support fire, fires that are destructive to Northern Spotted Owl habitat will likely continue in the future.

Given the ongoing risk of habitat loss due to wildfire, the Northern Spotted Owl is likely to continue experiencing loss of habitat in California.

Climate Change Impacts to Forest Composition and Structure

Most climate projection models indicate elevational and latitudinal shifts in forest habitats. In climate projection scenarios specific to California, the most notable response to increase temperature was a shift from conifer-dominated forests (eg., Douglas fir-white fir) to mixed conifer-hardwood forests (e.g., Douglas fir-tan oak) in the northern half of the state), expansion of conifer forests into the northeast portion of the state (e.g., Modoc Plateau), an increase dominance of oaks forest at the expense of pine forest, a general decrease in large trees and basal area, shifts of redwood forests inland into Douglas-fir-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

<u>Sudden Oak Death</u>

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.

The extent of sudden oak death impacts, as well as impacts resulting from control measures, 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.

Comment [JEH22]: Discuss rodenticides in this section or provide summary contaminants somewhere under Summary of Listing Factors.

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 is reliable estimates across the range or within California, and does not effectively sample nonterritorial floater individuals. Northern Spotted Owl 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 slow process given tree species growth rate (with a possible exception on the coastal redwood forests), and a rapid increase in the number of activity centers due to colonization of new habitat is unlikely.

One 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. 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 2011 USFWS Revised Northern Spotted Owl Recovery Plan. The study 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. Three provinces located in California were estimated to contain over 50 percent of the range-wide Northern Spotted Owl population, with the Klamath region in Oregon and California being a stronghold for the population. Even though the complexity of the model may limit its ability to accurately model population estimates, the results suggest that California's population of Northern Spotted Owls is an important component of the range-wide population.

Three large long-term Northern Spotted Owl demography study areas (Green Diamond Resource Company, Northwest California, and Hoopa Indian Reservation) in California have been monitored for more than two decades to assess demographic parameters such as population growth, survival, fecundity and occupancy. These three study areas are part of the larger meta-analysis covering 11 study areas range-wide. In California, the most recent meta-analysis covering years 1985-2008 reported a 2.8% per year population decline for Green Diamond Resource Company study area and a 1.7% decline per year for Northwest California study area. In 2015, the Willow Creek Study Area (part of the Northwest California study area) reported 2.4% annual population decline. Hoopa Indian Reservation study area reported a 2.3% population decline per year through 2012. When converting estimates for population change 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) two study areas in California (Green Diamond Resource Company and Northwest California) showed estimated population declines of about 20% through 2008, while the other study area (Hoopa Indian Reservation) showed only a slight decline in population size. The meta-analysis that will cover 1985-2013 is ongoing, but preliminary meetings regarding the analyses indicate that the decline in Northern Spotted Owl populations across the range is ongoing and accelerating; with an average rate of 3.8% population decline per year. The ongoing analysis has revealed declines in California between 32 and 55% over the study period.

In the most recent meta-analysis covering years 1985-2008, fecundity (e.g., number of female young produced per adult female) and survival estimates varied across the 11 study areas. Fecundity ranged from 0.230 to 0.553 across the range. In California, fecundity showed declines on two areas (Green Diamond Resource Company and Northwest California) and was stable other study area (Hoopa Indian Reservation). Adult survival has declined on 10 of 11 study areas, with declines most pronounced in Washington and Oregon. Although less severe than in Washington and much of Oregon, all three California study areas show declines in survival.

Though a meta-analysis covering years 1985-2013 is ongoing, recent reports from the study areas in California give us information on current estimates for reproductive success (number of young fledged per monitored site) and survival, and are consistent with a continued decline within all demographic study areas in California. 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 despite weather conditions that would typically support good reproductive success. This was observed on many timber company lands, tribal lands, and National Park land. The reason for this widespread pattern of low reproductive success in 2013 is not known. In 2015, Humboldt Redwood Company reported a reproductive rate of 0.49 in 2015, a drop in reproductive rate since 2009.

The authors of the most recent meta-analysis covering 1985-2008 expressed less confidence that study areas in California reflected trends on non-federal lands because two study areas are on non-federal lands near the southern edge of the subspecies' range and both are actively managed for Spotted Owl habitat. Therefore, some argue that results may not be accurately extrapolated to other non-federal land. However, the authors also suggest that results depict an optimistic view of the overall population status of the Northern Spotted Owl on private lands because the non-federal lands included in the demographic study areas are managed for owls. Results from the demographic study areas are thought to be 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 large, distributed across a broad geographic region, and contained a sufficient amount of owl habitat relative to the surrounding landscapes.

Occupancy data is based on the presence or absence of owls from known sites. 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.

Although an evaluation of occupancy rates has not been included in previous demographic meta-analyses, the authors of the most recently completed analysis covering 1985-2008 noted that the number of territorial owls detected on all 11 areas was lower at the end of the study period than at the beginning. The ongoing demographic meta-analysis covering 1985-2013 will include occupancy modeling for the first time. Preliminary results show that occupancy rates have declined at all three California study areas, with 32-37% declines from 1995-2013. Barred Owls were shown to have a strong effect on occupancy by increasing the local territory extinction rate.

Occupancy has been shown to be in decline for areas outside the California demographic study areas as well. For example, the southern Cascades and interior Klamath provinces of California determined occupancy probabilities declined approximately 39% over a 15 year period; site occupancy for any owl declined from 0.81 to 0.50, and pair occupancy declined from 0.75 to 0.46.

It is clear that the declining Northern Spotted Owl populations have not stabilized, and estimates of demographic rates across the range indicate the declines in demographic parameters, including population size, have accelerated. The level of decline does not seem to be slowing even with the implementation of the Northwest Forest Plan and the California Forest Practice rules. A careful look at threats leading to these declines is warranted, including revaluation of the effectiveness or management techniques across the Northern Spotted Owl range in California.

Predation

Though suspected predators of Northern Spotted Owls include Barred Owl, Northern Goshawk, Red-tailed Hawks, and other raptors, there is little evidence to suggest predation is a widespread threat. The 2011 Revised Northern Spotted Owl Recovery Plan also recognized that predation of Northern Spotted Owls is not a threat to the population. In the case of documented Barred Owl aggression toward Northern Spotted Owls, it is unclear if Barred Owls target Spotted Owls as prey, or if the documented mortalities were due to territorial aggression. Given that predation is not considered to be a major threat to Northern Spotted Owls at this time, the Department is not recommending actions to directly manage predation issues.

Competition

Over the last several decades, Barred Owls have gradually moved further into the range of the Northern Spotted Owl. The density of Barred Owls seems to be the greatest in the north, where they have been present the longest (British Columbia and Washington), with fewer detections made in the southern edge of the range (California) where they have been present for a shorter duration. Currently, Barred Owls have been documented in all portions of the Northern Spotted Owl range throughout California, though densities of Barred Owls are unknown.

Negative impacts of the Barred Owl range expansion to Northern Spotted Owls are of great concern to the conservation of the species. The Revised Northern Spotted Owl Recovery Plan lists one of the most important threats to the spotted owl as competition with Barred Owls. Northern Spotted Owl habitat and prey requirements completely overlap with that of the Barred Owl. Currently, there is no strong indication that the two species can coexist over time, sharing the same habitat and prey-base, because there is little suitable habitat or prey-base that can be exclusively used by Northern Spotted Owls and not by Barred Owls.

Public workshops held by the USFWS have resulted in four published and one unpublished meta-analyses since 1994 to assess population parameters, such as abundance, trend, and survival. 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 have been more prevalent where Barred Owls density was greatest. Northern Spotted Owl adult survival has declined in a majority of the range where Barred Owls were present, with a more gradual decline noted in California largely attributed to the relatively more recent Barred Owl expansion into this portion of the range. Presence of Barred Owls in or near Northern Spotted Owl territories is also thought to negatively impact fecundity, survival, and occupancy of Northern Spotted Owls.

Experimental studies to remove Barred Owls conducted in California demonstrated that 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, and that Barred Owl removal encourages Northern Spotted Owl recolonization.

Given the severity of impacts and the quick range expansion into California, the invasive 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~~and following implementation of experimental removal of Barred Owls. Exotic and invasive species control is analogous to wildland fire control in that the longer the delay in responding with countermeasures, the larger the outbreak becomes, making containment exponentially more difficult to obtain with the passage of time. Resource partitioning between the two species also needs further investigations. Therefore, operational Barred Owl control should be instituted as soon as possible. In addition, given the emotional response of some of the public and policy makers to the lethal take of Barred Owls, it is essential that outreach be conducted on the threat of invasive Barred Owls to Northern Spotted Owls and other wildlife, and the role of science in conservation.

Comment [JEH23]: Does it? Action is needed more than additional studies.

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~~ tick 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.

Comment [JEH24]: No other mention of mite in this document, so don't "mite" include in summary here.

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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 severity will increase due to warmer spring/summer temperatures, reduced precipitation, reduced snowpack, earlier spring snowmelts, and longer drier summers.

Several studies investigated temperature and precipitation effects on Northern Spotted Owls. These studies indicate that winter precipitation is closely associated with a decrease in survival and recruitment; population growth was positively associated with wetter conditions during the growing season (May through October) and negatively associated with cold/wet winters and nesting seasons, and during hot summers; reproduction decreased with cold wet nesting seasons; reproduction increased with late nesting season precipitation and decreased with warm temperatures; and owls may be more sensitive to changes in spring time climatic events. Higher summer temperatures could also result in more heat-stress during reproductive periods.

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 sever 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 information on the Northern Spotted Owl. The USFWS Recovery Actions (RA) are cited below where applicable. As new information becomes available, recommendations may be further refined.

<u>Planning and Timber Practices</u>

1. Encourage applicants to develop landscape-level planning (e.g., HCPs, NCCPs and SHAs) that is consistent with the recovery of the species (see RA14).

Comment [JEH25]: And NTMPs?, USFWS likes them.

2. Consider, analyze and incorporate, as appropriate, potential climate change impacts in long-range planning, setting priorities for scientific research and investigations, and/or when making major decisions affecting the Northern Spotted Owl (see RA5).
3. Assist USFWS in soliciting recommendations from stakeholders to facilitate creative opportunities for nonfederal landowners to engage in management strategies (see RA15).
4. Consider long-term maintenance of local forest management infrastructure as a priority in planning and land management decisions (see RA16).

5. Coordinate with USFWS, Board of Forestry, and CAL FIRE in developing scientifically-based and contemporary Forest Practice Rules to provide for the breeding, feeding and sheltering of Northern Spotted Owls (see RA21), and Rules that conserve existing owl sites and high quality habitat (see RA10).

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.

6. Coordinate with USFWS, CAL FIRE and individual stakeholders in evaluating: (1) the potential recovery role of Northern Spotted Owl sites and high-quality habitat on nonfederal lands in California, and (2) implementation of appropriate conservation tools (e.g., carbon sequestration, HCPs, NCCPs, SHAs) to assist with supporting recovery (see RA20).

7. Improve thorough documentation of harvest prescription methods within timber harvest plans and a rigorous evaluation of post-harvest levels of foraging, nesting, and roosting habitat.

8. Evaluate the effects of silvicultural practices on important prey species (e.g., flying squirrel, woodrat) and their habitat.

<u>Population Trend and Demographic Parameters</u>

9. Continue annual monitoring of the population trend of Northern Spotted Owls to determine if the California population is decreasing, stationary or increasing (see RA2).

10. Develop predictive modeling methodology for estimating Northern Spotted Owl occupancy across its California range (see RA3).

11. Assess the extent of climate impacts (e.g., precipitation, temperature, drought) on survival, population growth and reproductive rates of Northern Spotted Owls in California, and determine if negative impacts of climate change outweigh the positive ones.

<u>Habitat</u>

12. Manage younger and overstocked Northern Spotted Owl habitat in a way that accelerates the development of structural complexity and biological diversity that benefits Spotted Owl (see RA6)

13. Maintain and restore structurally complex multi-layered conifer forests (i.e., high quality owl habitat) while allowing for other threats, such as wildfire and insects, to be addressed by restoration management actions (see RA32).

14. Conserve Northern Spotted Owl sites and high value habitat to provide additional demographic support to population dynamics (see RA10).

15. Via habitat modeling process described in the USFWS 2011 Recovery Plan, assist the USFWS to inform decisions concerning the possible development of habitat conservation networks in California (see RA4).

16. Assess habitat requirements for, and barriers to, dispersal in California through research on Northern Spotted Owl movement (e.g., radio telemetry on juveniles), prey abundance and availability, and habitat modeling.

17. Participate in interagency work groups created by the USFWS (i.e., Dry Cascades and Klamath Province) to assist evaluating landscape-level issues in the Provinces in California, including monitoring and adaptive management actions (see RA7 and RA9).

Wildfire

18. Analyze existing data on Northern Spotted Owl occupancy pre- and post-fire (see RA8).

19. 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.

Comment [JEH27]: Implement active management to restore forest resiliency to fire and to reduce losses of nesting and roosting habitat to wildfire.

20. Conduct experiments to better understand how vegetation management treatments (e.g., thinnings, restoration projects, prescribed fire, etc.) influence the development of Northern Spotted Owl habitat, prey abundance and distribution, and demographic performance (see RA11).

    a. Inconsistencies in occupancy of sites by Spotted Owls post-fire, and inconsistencies in use of burned areas for foraging warrants additional research on long-term use of burned areas post-fire.

21. Gather information 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.

22. Assess if and how post-fire salvage logging impacts occupancy, foraging use, and survival of Northern Spotted Owls in areas that have experienced salvage logging and areas that have not.

23. Develop a process for evaluating the likely effects of post-fire management activities, such as salvage, fuels reduction, or hazard tree mitigation, on Northern Spotted Owls, and incorporate this process into post-fire management decisions.

24. Concentrate pre- and post-fire silvicultural activities on conserving and restoring habitat elements that take a long time to develop, such as large trees, medium and large snags, downed wood (see RA12).

Barred Owl

25. Continue investigations on the effects of Barred Owls on Northern Spotted Owl site occupancy, reproduction, and survival in California (see RA23).

26. Promote ~~experimental~~ removal of Barred Owls within Northern Spotted Owl range, and if lethal removal is deemed a ~~long-term management~~useful tool to manage negative effects of Barred Owls, explore methods for implementation within California (see RA22, RA28, RA29, and RA30).

27. Investigate ~~the potential for~~ resource partitioning of sympatric Barred Owls and Northern Spotted Owls (see RA26).

28. Investigate parasite host/parasites dynamics relating to the Barred Owls and Northern Spotted Owl interactions.

    a. Studies suggest that parasite dynamics in Northern Spotted Owls may be influenced by the presence or absence of Barred Owls, but other unknown factors may also play a role.

Disease and Contaminants

29. Monitor prevalence and extent of sudden oak death within the Northern Spotted Owl range in California, and ~~address as appropriate~~implement control measures where feasible (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 and active mitigation 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]

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 wildiife.

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 resource management agencies will allocate funds towards protection and recovery actions may increase.

Economic Considerations

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.

<u>Clearcutting</u>
Section 913.1(b) – Clearcutting regeneration method involves the removal of a stand in one harvest.

<u>Seed Tree</u>
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.

<u>Seed Tree Seed Step</u>
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)].

<u>Seed Tree Removal Step</u>
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).

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.

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.

<u>Shelterwood Removal Step [Coast only]</u>
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.

<u>Shelterwood Removal Step [Northern and Southern]</u>
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”.

<u>Selection/Group Selection</u>
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.

<u>Transition</u>

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

Section 913.4(b) – For the purposes of restoring and enhancing the productivity of commercial timberlands which do not meet the stocking standards defined in Section 912.7(932.7, 952.7) prior to any timber operations on such lands, an area may be harvested provided it is restocked in accordance with Subsections (1) or (2). To facilitate stocking, a regeneration plan must be included in the THP. The regeneration plan shall include site preparation, method of regeneration, and other information appropriate to evaluate the plan.

Fuelbreak/Defensible Space
Section 913.4(c) – Where some trees and other vegetation and fuels are removed to create a shaded fuel break or defensible space in an area to reduce the potential for wildfires and the damage they might cause.

Variable Retention
Section 913.4(d) - Variable retention is 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.

Conversion
Section 1100 – within non-timberland production zone (TPZ) timberland, transforming timberland to a nontimber growing use through timber operations.

Alternative Prescription
A written analysis of preharvest and postharvest timber stand conditions and a description of the silvicultural practices and systems to be used in lieu of the standard methods. 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.
Section 913.6 – When an Alternative method is used, the plan must include a statement of which silvicultural method in the current District rules is most nearly appropriate or feasible and an explanation of why it is not appropriate or feasible. The plan must also provide an explanation of how the proposed alternative prescription will differ from the most nearly feasible method in terms of securing regeneration; protection of soil, water quality, wildlife habitat, and visual appearance; and in terms of fire, insect and disease protection.

NonTimberland Area
Anything Not Timberland (e.g.) as defined in 895.1 and 4526. Timberland as defined in 4526, is land, other than land owned by the federal government and land designated by the board as experimental forest land, which is available for, and capable of, growing a crop of trees of a commercial species used to produce lumber and other forest products, including Christmas trees.

Road Right of Way
No strict definition

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

such as those created by a hawk or squirrel nest, mistletoe broom, or accumulated debris. Owls are known to occasionally nest in less than optimal habitat. Nesting areas may also be associated with characteristics of topographic relief and aspect which alter microclimates.

Functional Roosting Habitat during the territorial breeding season, consists of stands where average stem diameter is >11" dbh among dominant and co-dominant trees. Hardwood and conifers provide an average of at least 40% canopy closure but the stand can have a high degree of variability. Stand size and configuration must be sufficient to provide multiple perch sites which are suitable for protection from various environmental conditions, including wind, heat, and precipitation.

Owl Habitat means Type A, B, or C owl habitat or those areas with functional foraging habitat, functional nesting habitat, and functional roosting habitat which support the owl's biological needs for breeding, sheltering, and feeding. An area of habitat could have characteristics which support all of the functional needs for nesting, roosting, and foraging or a combination of those functions. Because owls are known to occasionally inhabit less than optimal forest structure, local information can be used to justify the modification of functional habitat definitions.

Type A Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy layers: The stand has two distinct tiers or is multi-layered with dominant conifers greater than 120 ft. tall (trees greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 120 ft. tall.

2. Canopy Closure: The canopy closure of conifers greater than 120 ft. tall (or greater than 90 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.

3. Large Trees: The density of conifers greater than 35 in. dbh averages more than nine stems per acre and not less than six stems per acre and includes a component of trees with sparse, broken, or dead tops.

4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre and not less than 8 stems per acre.

5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type B Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:

1. Canopy Layers: Moderately to strongly two-tiered or multi-layered with dominant conifers greater than 100 ft. tall (greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species). Conifers or hardwoods dominate the canopy layers less than 100 ft. tall.

2. Canopy Closure: The canopy closure of conifers greater than 100 ft. tall (or greater than 70 ft. tall on poor sites, less than site III, and for some montane tree species) averages greater than 40% and not less than 20%. The total closure for all trees, conifers or hardwoods, is greater than 60%.

3. Large Trees: The density of conifers greater than 35 in. dbh averages more than six

stems per acre and not less than two stems per acre.
4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 25 stems per acre and not less than 20 stems per acre.
5. Small Trees: The density of conifers or hardwoods less than 18 in. dbh averages more than 50 stems per acre and not less than 20 stems per acre.

Type C Owl Habitat means timber stands that have as a minimum the following characteristics for live-tree structure:
1. Canopy Layers: Uniform to moderately layered with dominant conifers or hardwoods 50 to 100 ft. tall although low numbers of emergent trees greater than 100 ft. tall may be present.
2. Canopy Closure: The canopy closure of conifers or hardwoods 50 to 100 ft. tall averages greater than 40% and not less than 20%. The total canopy closure for all trees, conifers or hardwoods, is greater than 60%.
3. Large Trees: The density of conifers greater than 35 inches dbh averages less than six stems per acre and may be absent.
4. Medium Trees: The density of conifers or hardwoods 18 to 35 in. dbh averages more than 15 stems per acre, but may be absent.
5. Small Trees: The density of conifers or hardwoods less than 18 inches dbh averages more than 160 stems per acre and not less than 50 stems per acre. The average dbh for all trees in the stand, including small, medium, and large trees is greater than 10 inches.

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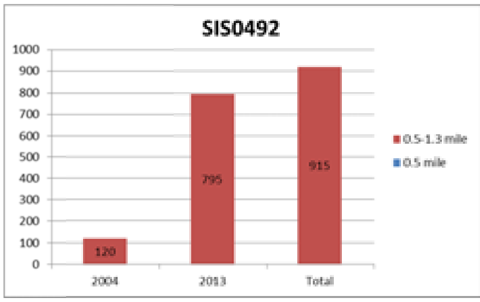
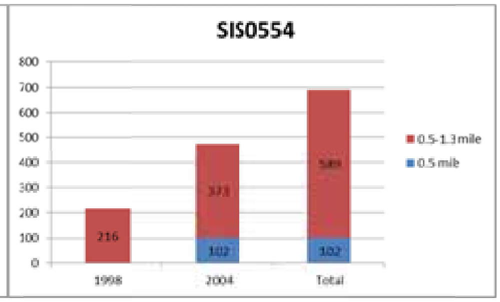
Appendix 3. Bar graphs for each Activity Center (AC) within the coast and interior and level of harvest within 0.5, 0.7 and 1.3 mile radius from the AC.

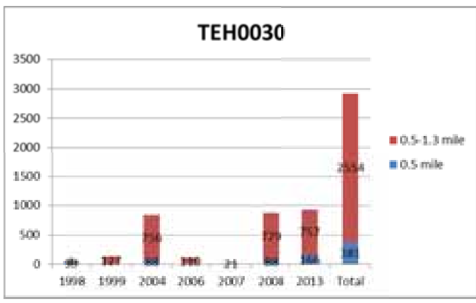
Comment [JEH34]: Does this include all or a subset of ACs?

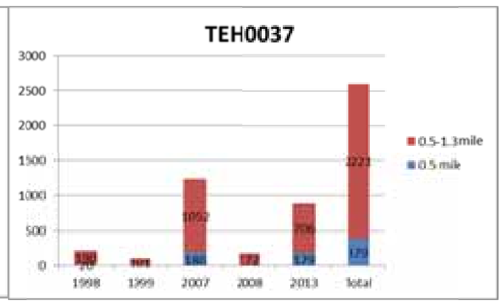
Comment [JEH35]: Coast and interior physiographic provinces? Appendix title needs improvement.

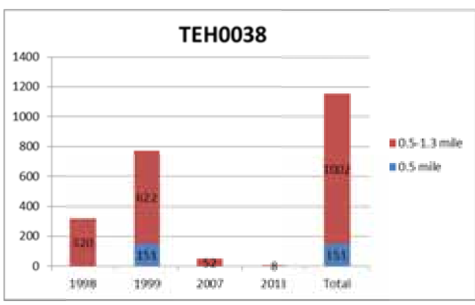
THP's utilizing Option (e) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC.

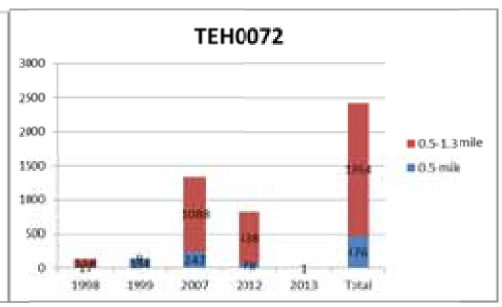












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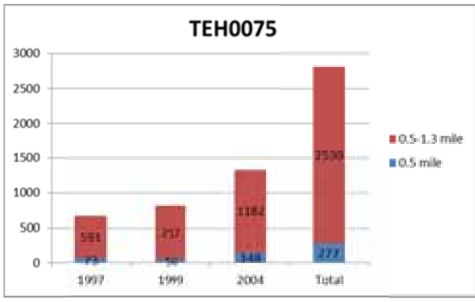

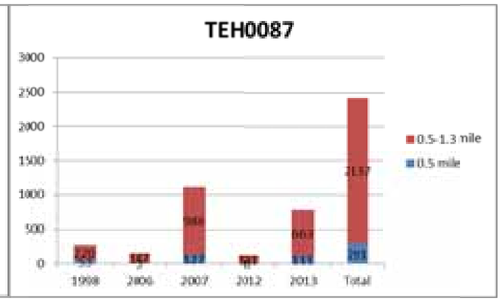

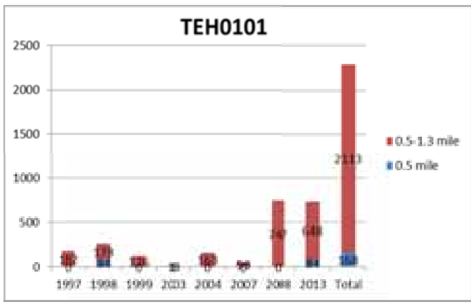

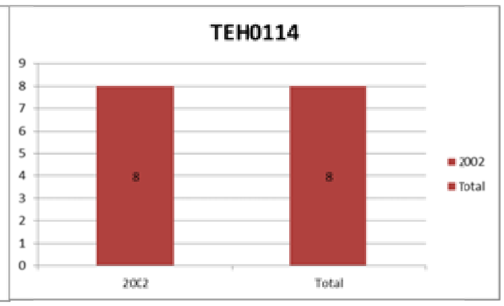

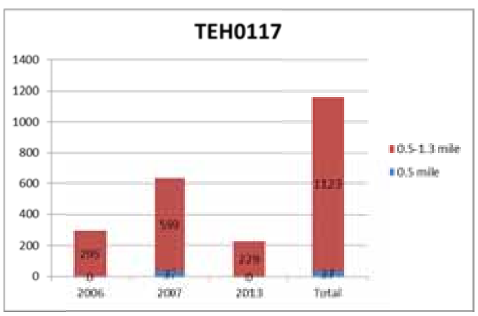

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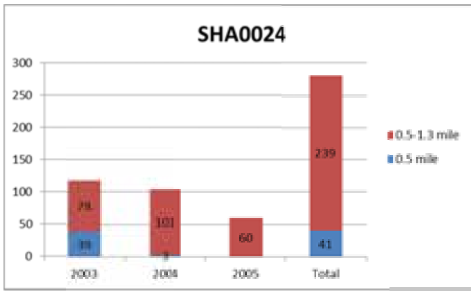
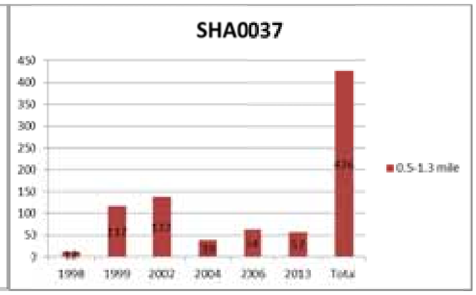
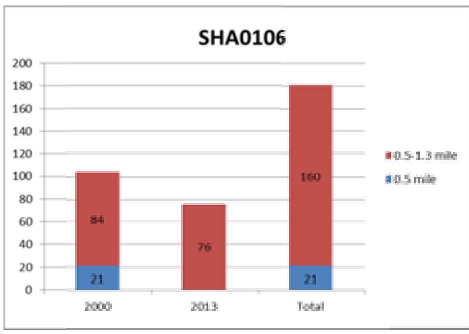
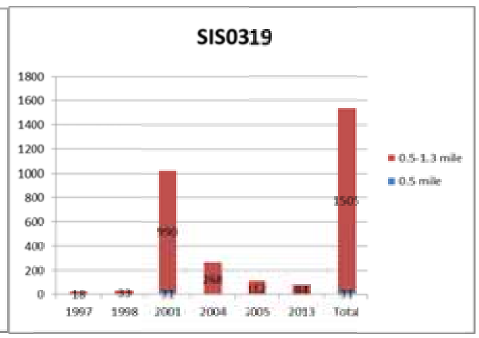
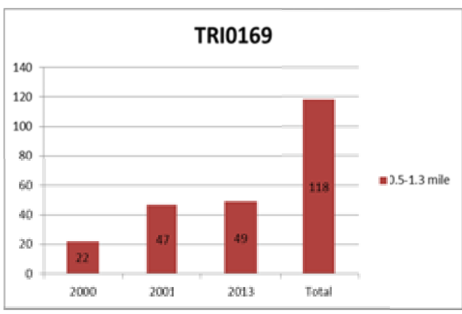
THP's utilizing Option (g) in the interior, showing cumulative harvested acres within 0.5 mile and 0.5-1.3 mile of an AC

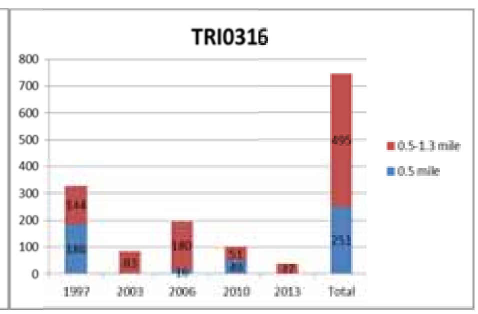












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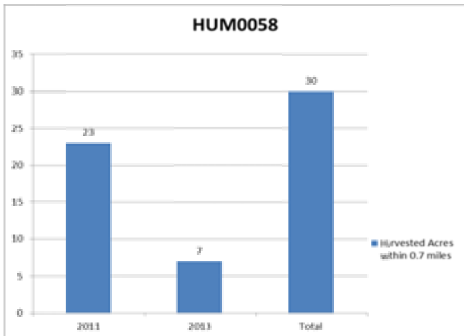
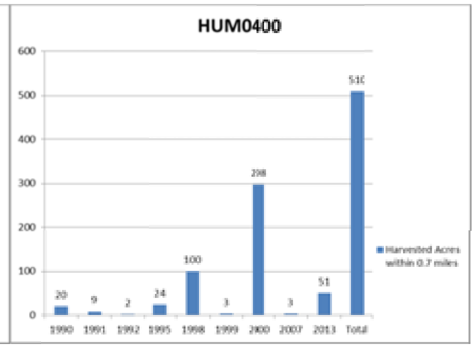
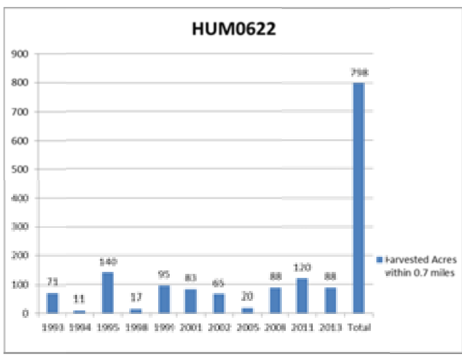
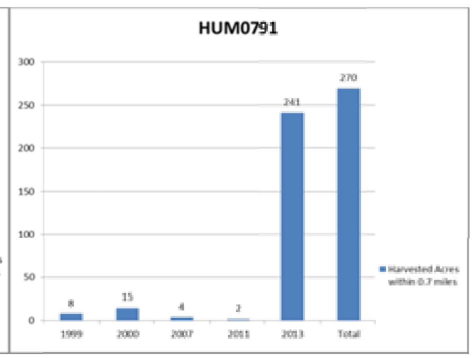
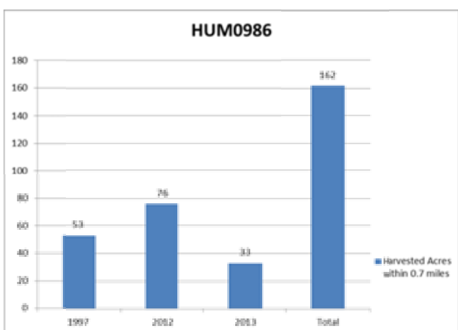
THP's utilizing Option (e) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

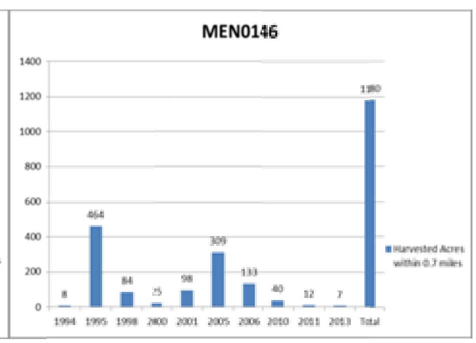


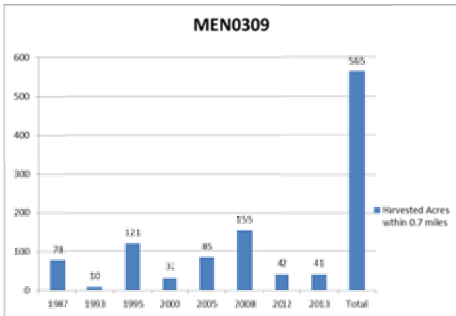








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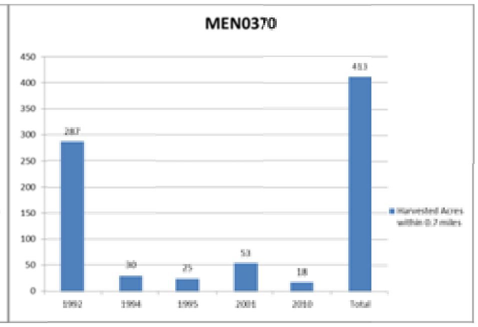
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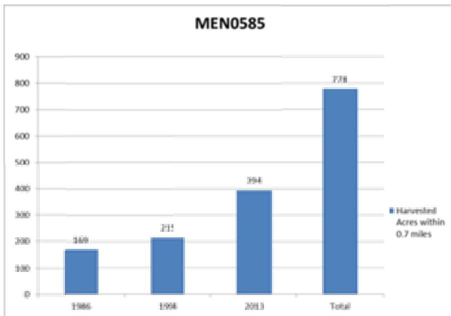
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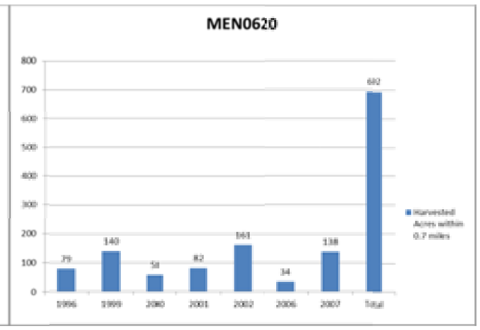
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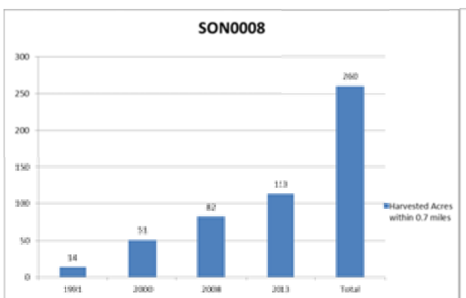
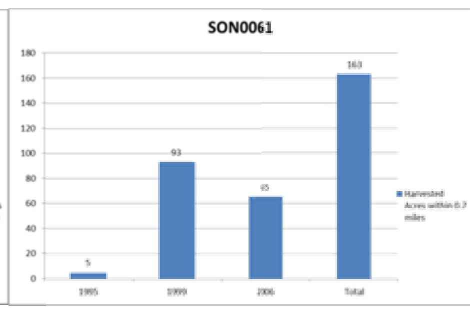

SON0008
Harvested Acres within 0.7 miles


SON0061
Harvested Acres within 0.7 miles

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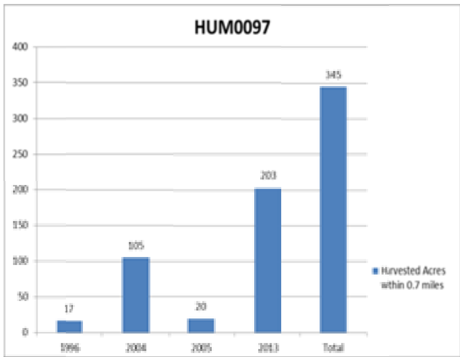
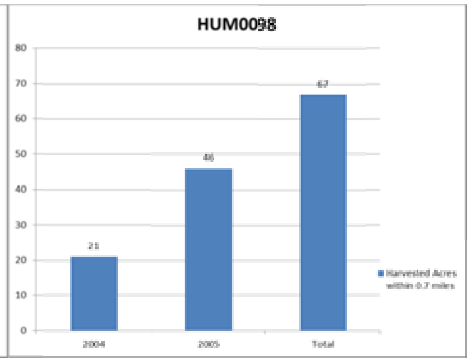
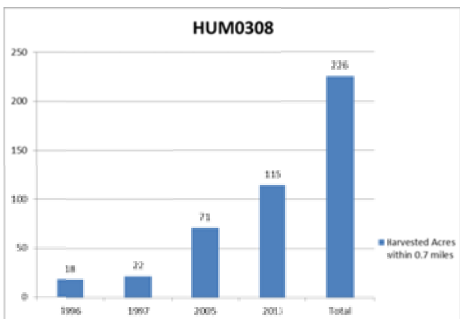
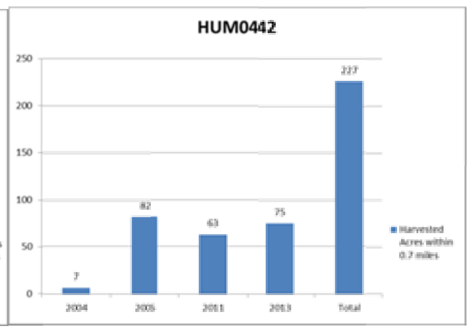
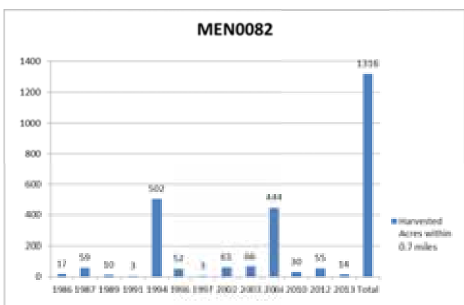
THP's utilizing Option (g) in the coast, showing cumulative harvested acres within 0.7 mile of an AC.

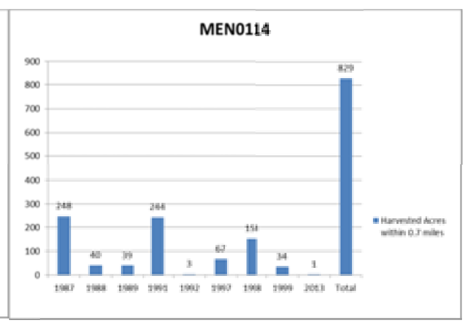












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Appendix 4. List of Acronyms and Abbreviations

AC	Activity Center
AMA	Adaptive Management Areas
AR	Anticoagulant Rodenticides
BLM	Bureau of Land Management
Board	Board of Forestry and Fire Protection
BO	Biological Opinion
BOE	Board of Equalization
BOF	State Board of Forestry and Fire Protection
CA State Parks	California Department of Parks and Recreation
CAL FIRE	California Department of Forestry and Fire Protection
Caltrans	California Department of Transportation
CBD	Center for Biological Diversity
CD	Consistency Determination
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CCAA	Candidate Conservation Agreement with Assurances
CDFW	California Department of Fish and Wildlife
CI	Confidence Interval
CNDDB	California Natural Diversity Database
Commission	Fish and Game Commission
CPV	Canine Parvovirus
CSA	Conservation Support Areas
CWHR	California Wildlife Habitat Relationships
DBH	Diameter at Breast Height
DSA	Density Study Area
Department	California Department of Fish and Wildlife
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
ESA	Federal Endangered Species Act
FEIS	Final Environmental Impact Statement
FRGP	Fisheries Restoration Grant Program
FGS	Fruit Growers Supply Company
FEMAT	Forest Ecosystem Management Assessment Team
FIA	Forest Inventory Analysis
FMP	Forest Management Plan
FPA	Forest Practice Act
FRI	Fire Return Interval
FSC	Forest Stewardship Council
GDR	Green Diamond Resource Company study area
GDRC	Green Diamond Resource Company
ITP	Incidental Take Permit
ITS	Incidental Take Statement
JDSF	Jackson Demonstration State Forest
HCP	Habitat Conservation Plan
HFP	Habitat Fitness Potential

HCVF	High Conservation Value Forests
HUP	Hoopa Indian Reservation study area
HRC	Humboldt Redwood Company
LSA	Late-Successional Areas
LSAA	Lake or Streambed Alteration Agreement
LSR	Late-Successional Reserve
MBF	1,000 board-foot
MIS	Management Indicator Species
MMCA	Marbled Murrelet Conservation Areas
MRC	Mendocino Redwood Company
NCA	National Conservation Area
NCCP	Natural Community Conservation Plan
NIPF	Non-industrial private forest
NPS	National Park Service
NSO	Northern Spotted Owl
NTMP	Nonindustrial Timber Management Plans
NTO	Notice of Operations
NWC	Northwest California study area
NWFP	Northwest Forest Plan
ORV	Off Road Vehicle
PCB	Private Consulting Biologists
PFT	Pacific Forest Trust
PL	Pacific Lumber Company
PRNS	Point Reyes National Seashore
PSU	Primary Sampling Unit
REF	Suppressed reproduction and growth
RNSP	Redwood National and State Parks
ROD	Record of Decision
RPF	Registered Professional Foresters
SEIS	Supplemental Environmental Impact Statement
SHA	Safe Harbor Agreement
SOMP	Spotted Owl Management Plans
SOP	Spotted Owl Expert
SORP	Spotted Owl Resource Plan
SFI	Sustainable Forestry Initiative
SP	State Park
SPI	Sierra Pacific Industries
TCP	Timberland Conservation Planning Program
THP	Timber Harvest Plan
TPZ	Timber Production Zone
UCNRS	UC Natural Reserve System
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USFS	United States Forest Service
WCSA	Willow Creek Study Area
WLPZ	Watercourse and Lake Protection Zones

WNV	West Nile virus