APPENDIX 8. PUBLIC COMMENTS

Public Comments below represent emails and comment letters in relation to providing information on the Northern Spotted Owl's status in California. Some of the commenters sent attachments, studies, reports, etc. CDFW has those documents available but did not attach them here because of their excessive size. They are available upon request.

Loft, Eric@Wildlife

From:	Mara Thompson <mythmara@icloud.com>
Sent:	Monday, January 27, 2014 4:22 PM
To:	Wildlife Management
Subject:	Northern Spotted Owl

Please add this bird to CA endangered species list.

Best, Mara Thompson
Santa Monica, CA

Sent from my iPad

Loft, Eric@Wildlife

From: Mary Vuong <mvuong1961@yahoo.com>
Sent: Monday, January 27, 2014 4:53 PM
To: Wildlife Management
Subject: Northern Spotted Owl

Yes! I want to see the Northern Spotted Owl protected!! Please.

Mary Vuong
40485 Vista Rd.
Hemet, CA 92544
(951) 722-1492

Sent from Yahoo Mail on Android

Loft, Eric@Wildlife

From: Joel Easton <onestringking@gmail.com>
Sent: Monday, January 27, 2014 5:02 PM
To: Wildlife Management
Subject: Northern Spotted Owl

Gentlemen,

Saving the Northern Spotted Owl requires it's inclusion on the endangered species list. Saving this species' habitat saves many other species as well. List the owl. We don't need "old growth timber products".

Loft, Eric@Wildlife

From: Scott <eraserheadz@gmail.com>
Sent: Saturday, February 08, 2014 9:07 AM
To: Wildlife Management
Subject: Northern spotted owl

Asking citizens for input on this astounding no-brainer is laudable but indicative of incompetence in the agency.

Old growth forests should NEVER be cut or cleared for any reason, much less for ephemeral product. These ancient trees store CO2, and we're in the midst of a climate crisis. They also house needed biodiversity, of which the owl is a single inhabitant among many.

Whoever in the agency that is recommending these trees should be cut is unfit for government service and should be removed without haste. As a well-published journalist, I'm happy to help. Just give me a name...

Sent from my iPhone

Loft, Eric@Wildlife

From: Joseph Glatzer <jglatze@wgu.edu>
Sent: Friday, February 14, 2014 10:20 PM
To: Wildlife Management
Subject: Northern spotted owl

I think the northern spotted owl should receive endangered status. Also, it should have its forest habitat protected from any sort of resource exploitation such as the timber industry or any kind of drilling or fracking. This owl needs to be left alone and be able to live a normal life. Thank you.

Joseph Glatzer, San Diego, CA

Loft, Eric@Wildlife

From: Dan Richman <danrichman@earthlink.net>
Sent: Saturday, August 09, 2014 5:39 PM
To: Wildlife Management
Subject: northern spotted owl

People, Please place this endangered bird on the endangered species list. Every one of us must change our ways of life in order to save the planet. And so the lumber guys might have to find another way to pay their mortgages and their truck payments.

Your respectfully,

Dan Richman
\San Francisco

Loft, Eric@Wildlife

From: Windy <windnfog@gmail.com>
Sent: Friday, January 24, 2014 2:17 AM
To: Wildlife Management
Subject: Spotted Owl

Hi folks,

I'd like to see the spotted owl listed as endangered. We are killing off too much too fast.

Peace,
Windy

Loft, Eric@Wildlife

From:	ACE CARTER <acecarter2000@yahoo.com>
Sent:	Wednesday, January 22, 2014 5:41 AM
To:	Wildlife Management
Cc:	FGC; California Assemblyman Steve Fox; California State Senator Steve Knight
Subject:	Public Opinion Sought By DFW About The SPOTTED OWL

Public Opinion Sought By DFW About The SPOTTED OWL

Read it here...

http://outdoornewsdaily.com/cdfw-seeks-public-comment-related-to-northern-spotted-owl/

MY OPINION...

OUR fishing and hunting license monies should NEVER be used for anything other than protecting and **IMPROVING** outdoor activities, especially fishing and hunting with **OUR license fees...**

The Spotted Owl has always been associated with fringe enviromentalism and **scientific FRAUD** in USFS "Studies.."

CLOSE DOWN ALL such nonsense at OUR DFW soon...

A 3rd. Generation Native Californian and Licensed Angler
Ace Carter
Post Office Box 821
Pearblossom CA 93553
661-944-3546

Loft, Eric@Wildlife

From: Bill Kauffman <kbill1@frontiernet.net>
Sent: Tuesday, January 28, 2014 1:31 PM
To: Wildlife Management
Subject: Northern Spotted Owl

Sir: Is this going to be the same debacle that was caused by USFS and other government agencies, along with Animal Rights groups that shut down and ruined the lives and business's of the thousands in the lumber/logging business over the spotted owl ? According to those people loggers and cutting of timber was the cause of the decline of the spotted owl, and now as so many said before, it was not them that did it, but another owl moving into their territory. How much money is going to be wasted now, on this project ? Is it really worth it ? Or would it be best to just let nature and the law of survival run it's course ? Seems to me that $150.00 to 200.00 per bird, by government hunters/trappers is way too much to give them. But, I would assume, that like always the government knows best and will do what it wants, regardless of how many citizen's it puts out of work or how much taxpayers money is wasted. Thank you for you time: Bill Kauffman, Lake Forest, Ca.

Loft, Eric@Wildlife

From:	Jennifer J <buckingham72@hotmail.com>
Sent:	Thursday, January 23, 2014 11:45 PM
To:	Wildlife Management
Subject:	Northern spotted owl endangered or threatened species

California Department of Fish and Wildlife
Nongame Wildlife Program
Attn: Neil Clipperton

Dear Mr. Clipperton,

The Northern spotted owl population is declining throughout British Columbia, Washington, and Canada. The threats to the Northern spotted owls and to their habitats continue to increase. This is due to loss of habitat, wildfire, competition from barred owls, disease, pesticide poisoning and climate change among other factors.

I do think this is a matter that needs to be addressed immediately before more deaths occur. Please list the Northern spotted owl as an endangered or threatened species. Thank you.

Sincerely,

Jennifer Sellers
3901 Clayton Road #66
Concord, CA 94521

Loft, Eric@Wildlife

From: Sylvia De Rooy <oftheforest@att.net>
Sent: Wednesday, January 22, 2014 2:05 PM
To: Wildlife Management
Subject: Northern Spotted Owl

The Northern Spotted Owl is facing more dangers than ever with the continuing heavy deforestation, barred owls, over all depredations that lessen the availability of food and more. They must be protected by being listed as a threatened or endangered species.
Sylvia De Rooy
Eureka, CA

Loft, Eric@Wildlife

From:	Maya Elson <armillarianabs@gmail.com>
Sent:	Thursday, January 23, 2014 4:53 PM
To:	Wildlife Management
Subject:	Northern Spotted Owl

Hello,
As a rural citizen scientist of California, I believe it is imperative that we list the Northern Spotted Owl as an Endangered Species. After reviewing the data and keeping up with the developments in the status of the owls over many years, it is clear that the species is in danger of going extinct. Listing them is a very important step in their survival and recovery.

Thank you,
Maya Elson

Loft, Eric@Wildlife

From: Ellen Houser <ellenhouser@gmail.com>
Sent: Thursday, January 23, 2014 6:16 PM
To: Wildlife Management
Subject: Northern Spotted Owl

The Northern Spotted Owl is the canary in the coal mine, if you accept the forest as a metaphor for the coal mine. If the forest will not sustain the owl, the forest is sick. Humankind's "management" of wild animals and wild lands is a long and sorry history of rampant destruction for shot-term profit, devastation and extinction after extinction. We are destroying life on this planet at an astonishing rate. Save the owls, save ourselves.

Thank you.

Earl Frounfelter
120 Palm Court Drive
Santa Maria, CA 93454

Loft, Eric@Wildlife

From: MargoYC@aol.com
Sent: Friday, January 24, 2014 10:42 PM
To: Wildlife Management
Subject: Northern Spotted Owl

I support the effort to list the Northern Spotted Owl as an endangered specie.

Margaret Chapman 4957 La Ramada Drive Santa Barbara, CA 93111

Loft, Eric@Wildlife

From:	Cody Dolnick <woland92107@yahoo.com>
Sent:	Saturday, January 25, 2014 2:18 PM
To:	Wildlife Management
Subject:	Northern spotted owl

Dear CDWF,

I am in favor of granting endangered species protections to the Northern Spotted Owl.

sincerely,
Cody Dolnick
PO Box 942
Joshua Tree CA, 92252

From:	Whitney, Kate-Contractor@Wildlife
To:	Battistone, Carie@Wildlife; Clipperton, Neil@Wildlife
Subject:	Sonoma SPOW (1)
Date:	Tuesday, April 29, 2014 9:13:16 AM
Attachments:	NSO DATA 1976-2013 from JMB_Part1.pdf

Good morning,

I received a large report from Jim Berry regarding his spotted owl surveys in Sonoma County from 1976-2013. He includes some commentary so I figured I would pass it along for your review. Due to file size, I split the report in half. The first half has most of his commentary but there are a few notes and letters sprinkled throughout the second half. He believes that the state's database has been perpetually outdated so he and I are working together to make the appropriate updates. He also had this to say after I asked if I could forward his report to you:

> The most important comment I would pass on to those working on the status review is that many more follow-up surveys need to be made in Sonoma County to determine current status of NSO's discovered in the last 24 years. My current survey work presses me hard already, so it will take time to find and evaluate past Activity Centers. The Barred Owl has had a dramatic effect on NSO Activity Centers. However, I am finding some atypical situations with Barred Owls. Two of my Barred Owls on Family property are in non NSO areas even though the habitat seems fine for NSO's. One new situation (also on family property) is that one NSO pair has held its own against a new Barred Owl presence. The male and female have continued to call an defend their territory. The NSO's I am aware of are maintaining their territories. In Sonoma County, Habitat has remained steady in Sonoma County and is gradually improving.
> Jim

I'm currently working on pulling all the data out of the report. It's slow going.

Kate

Kate Whitney
Spotted Owl Database Manager
(916) 445-5006
Kate.Whitney@wildlife.ca.gov

From: Carr, Christopher J. <CCarr@mofo.com>
Sent: Wednesday, April 30, 2014 11:42 AM
To: Wildlife Management
Cc: kenb
Subject: Northern Spotted Owl
Attachments: Burnham NSO Review Report.pdf

Dear Sir/Madam:

Dr. Kenneth Burnham has asked me to submit the attached "Review Report" for him because he is indisposed by a medical situation.

Dr. Burnham's e-mail address and contact information is:

kenb@lamar.colostate.edu

Kenneth P. Burnham
Colorado Cooperative Fish and Wildlife Research Unit
Emeritus Assistant Unit Leader
201 Wagar Building
Colorado State University
Fort Collins, CO 80523

Please let me know if any further information is required.

Thank you.

Chris Carr
Morrison & Foerster LLP
425 Market Street
San Francisco, CA 94105-2482
415-268-7246

Review Report of Kenneth P. Burnham
Concerning EPIC's Petition to List the Northern Spotted Owl as "Threatened" or "Endangered" Under the California Endangered Species Act

April 25, 2014

I was asked by the California Forestry Association to review and evaluate EPIC's Petition to List the NSO and the Northern Spotted Owl Science Compendium, compiled by the California Forestry Association, for their scientific soundness and, particularly, their respective data and conclusions based on those data regarding NSO population abundance and dynamics in California. My review of EPIC's Petition reveals it to be replete with irrelevant information (e.g., information about NSO in Washington and Oregon), hyperbole (e.g., that the NSO is "close" to extinction), and unsupported assertions (e.g., NSO have been largely extirpated on state and private lands). EPIC's Petition does not reflect science, let alone the best available science, and is simply not credible. The NSO Science Compendium provides reliable information on the status and population trend of NSO in California, including, critically, on private lands. The data in the NSO Science Compendium demonstrates that the California population of NSO is reasonably abundant and stable in numbers over at least the past 15 years.

I. Background and Experience

I am a retired Senior Scientist with the United States Geological Survey, Biological Resources Discipline, Colorado Cooperative Fish and Wildlife Research Unit. *See* Summary Professional Vitae, attached hereto as **Exhibit A**. I held that position from 2004 to 2008, and worked in various positions within the same Unit since 1988. I have a Ph.D. in Statistics from Oregon State University, a Master's of Science in Statistics from Oregon State University, and a Bachelor's of Science in Biology from Portland State University. I taught graduate-level courses such as "The Design of Fish and Wildlife Studies" and "Sampling Biological Populations" for nearly twenty years, and I was most recently a graduate professor in the Department of Fish, Wildlife, and Conservation Biology and affiliate faculty in the Department of Statistics at Colorado State University from 1988 to 2008.

I am the author of some 200 publications, reports, and articles, including Burnham, K.P. and D. R. Anderson, *Model Selection and Multimodel Inference* (2nd ed.), Springer-Verlag (2002). With respect to the NSO, in particular, I have authored numerous publications, including, for example, Burnham, K. P., D. R. Anderson and G. C. White, *Meta-analysis of vital rates of the northern spotted owl*, Studies in Avian Biology 17:92-101 (1996); Franklin, A.B., D.R. Anderson, R.J. Gutierrez, and K.P. Burnham, *Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California*, Ecological Monographs 70:539-590 (2000); and Forsman, Eric D., et al, *Population Demography of Northern Spotted Owls*, Studies in Avian Biology 40 (2011).

I have additional professional experience as an elected committee member of the Western North American Region ("WNAR") of the International Biometric Society from 2004-2006, and served as President of WNAR in 2007. I was an Associate Editor of the journal Biometrics from 1997 to 2000. I served on the Editorial Board of the Ecological Society of America from 1989 to 1992, acting as an associate editor of the journals Ecology and Ecological Monographs. In addition, I am a member of several professional societies, including the American Statistical

Association (since 1967, Fellow since 1990), International Biometric Society (since 1968), the Wildlife Society (since 1978), and the International Statistical Institute (elected member since 2007), as well as the Ecological Society of America (1990-2001).

I have received numerous professional awards and recognitions for both my academic work and my work with federal wildlife agencies. I was awarded a Meritorious Service Award from the United States Department of the Interior in 2006, which is the second highest honor awarded within the Department. I was privileged in 2011 to receive the Aldo Leopold Memorial Award from The Wildlife Society.

II. EPIC's Petition

As summarized above, EPIC's Petition fails to meet basic scientific standards, relying on data that is irrelevant, incomplete, and/or whose reliability cannot be assessed. The irrelevance of information about the NSO in Washington and Oregon to the NSO in California, which, among other important differences, has a very different regime for the regulation of timber harvesting and NSO conservation, is too obvious to require elaboration. Perhaps less obvious is EPIC's playing fast-and-loose with other information about the NSO. Only a few highlights of the Petition's misleading treatment of information will be noted here.

EPIC asserts that "in California, populations are declining in two of three long-term monitoring sites, while numerous historic territories have been lost from interior forests in California." Petition at 7. With respect to alleged population declines in California, EPIC fails to account for declines in *detection*, as against actual population declines, as a result of NSO not responding to hooting-based sampling because of exposure to barred owls. EPIC's assertion of alleged "lost territories" is profoundly misleading because it entirely fails to recognize or account for new or reoccupied territories. Any unbiased assessment must include information/evidence on such (re)establishment of new or old territories. As explained below, the NSO Science Compendium does just that, providing data that refute EPIC's "lost territories" claim.

EPIC makes much of the "low reproductive rate" and "high variation in northern spotted owl demographic rates." Petition at 5, 11. However, low reproduction is simply not an issue because the species is long-lived. Indeed, being long-lived, its low reproductive rate is natural; it can reproduce over 10, 15, 20 years. The published science literature shows that adult survival probability is quite stable from year-to-year. Fecundity (reproductive success) is variable because of fluctuating environment, including weather and prey. But, as noted, this variation is not critical because of longevity – if a pair fails to produce one year, they have many more years to succeed.

Also problematic is the Petition's creation of a table of population trends for NSO in different study areas, including three in California, from 1995-2008. Petition at 13, Table 1. Of course, only the three California entries are even potentially relevant, but the Petition seems to engage in hand waving here by describing trends qualitatively instead of quantitatively, and by failing to address the magnitudes of any growth rate changes, which were quite small. See Forsman et al (2011) at page 44 (Table 19) and page 57 (Figure 12 C). What is more, as set forth in the Green Diamond Resource Company Annual Report, submitted to the U.S. Fish and Wildlife Service as required by its Habitat Conservation Plan for NSO (and included in the NSO Science Compendium), any negative trend appears to have been reversed by barred owl control. See NSO Science Compendium at 148.

The last example I will address concerns the Petition's quotation of a U.S. Fish and Wildlife Service document prepared by its Yreka Field Office in 2009. Petition at 20 (quoting USFWS (2009)). Simply put, the 54% (percentage of NSO sites on private lands that declined from pair status to no response) vs. 80% (percentage of NSO pair sites on Forest Service lands that did not change status during the same time periods) figures are not meaningful here. NSO are known to have some year-to-year relocation of nesting. Habitat is generally more stable on federal lands, and perhaps more fluctuating on private lands (which might cause more movement on private lands), but, more important, when owls vacate a territory, for whatever reason, it is not necessarily that they died (this appears to be EPIC's implication). They may have just moved. One needs banded owls, or preferably radioed owls, in order to know precisely what happened. Did they move, are they somewhere else? The observational data quoted in the Petition are logically flawed, as constituting a "study," because it is not known (apparently) what became of displaced, or otherwise vanished owls. As such these numbers (54% vs. 80%) are meaningless as regards the critical demographic parameters of survival and reproduction. Another way to put this: they did not have information on territories not occupied at time 1, then occupied 5-10 years later. So it is like an experiment with a treatment only – no controls. Also, no details of data collection are provided: Was the average time between checking territories the same or not on the federal vs. private lands? If there was a longer average time between checking this could bias the results. In general, one must give relevant study details (which was not done here) in order to know what inferences are justified. Thus, there is no basis to know what 80% vs. 54% means, or does not mean, for NSO population demographics. What matters to the future of the NSO is its population abundance and trend.

III. NSO Science Compendium

The NSO Science Compendium, taken as a whole, is a comprehensive collection of high-quality data. Overall, the effort expended in monitoring and data collection on private timberlands as regards the NSO in California is, in my opinion, exemplary. With more than a dozen NSO monitoring documents, it is to be expected that some of those studies are more informative (i.e., "stronger") than others. A critic might focus on weaknesses, or even look for the weakest study and make the analogy that a chain is only as strong as its weakest link. This would be a very flawed analogy. The proper analogy is that each document (area study) is like a strand in a tapestry and said "tapestry" is much stronger than any one strand. In fact, the strength of evidence arising from the combined strengths of all the information is much greater than in any one document. Thus, the focus should be on the picture presented by the totality of the documents.

Overall, just the quantity of evidence (call it that) is impressive, and shows that NSO occur all over their putative range in northwest CA (in a somewhat uniform manner). Assuming the 3,061 known NSO pair territories number is well-documented (and I believe it is), this is robust abundance. While the dramatic increase in known NSO pair territories since 1988 is likely due principally to more survey effort and more places surveyed, it is consistent with the dynamic but stable and robust NSO population in California evidenced by the data collected in the Compendium. Such a dynamic but stable, in the long term, and robust, population is also consistent with the long-lived character but variable reproductive success (due to weather and other environmental factors) of the species, discussed above.

The data show that NSO abundance has been stable in California. As already discussed above, the Petition's "lost territories" assertion is fallacious and misleading because it fails to account for (re)establishment of old or new territories as owls move on the landscape. A number of the studies in the NSO Science Compendium, including those of some of the largest timberland owners, provide credible density data showing a stable NSO population in California. For example, the Sierra Pacific Industries contribution to the Compendium (at pages 49-59) shows a stable NSO density in the study area. Indeed, for this study area, if the percentage of site occupied were estimated, it would be steadily decreasing even though the actual number of *occupied* activity centers remained stable over the ten years of the study. The fundamental stability of the NSO population in California is critical.

The data also show that the NSO has been widely distributed throughout its range in California since it was federally listed in 1990. It appears that any potential threat to this wide distribution posed by the barred owl can be effectively addressed by invasive species control efforts, as evidenced by the success of Green Diamond Resource Company in this regard. <u>See</u> NSO Science Compendium at 3-4, 150-54.

The data in the NSO Science Compendium justify Calforests' conclusion that:

> The original and applied science and monitoring activities our members' biologists and foresters have been conducting over the past years, decades, and in some cases quarter century of monitoring Northern spotted owl habitat needs and populations have led to the conclusion that California's NSO population is well distributed across the landscape [and] is dynamic yet stable over the past quarter century.... [NSO Science Compendium at 15][1]

IV. Is Listing the NSO Under CESA Warranted?

No. Based on my review of EPIC's Petition and the NSO Science Compendium, there is no credible basis for finding listing the NSO under CESA warranted. The available data on NSO in California show the population to be dynamic, but stable and robust. Contrary to EPIC's unsupported assertions, timber harvesting on private lands in California does not threaten the NSO. Finally, the barred owl will indeed be a threat to the NSO if measures are not implemented to halt its invasion of California forests, but the Green Diamond Resource Company barred owl control measures show this can be done successfully.

[1] I will not opine specifically on the third clause of Calforests' conclusion (at page 15 of the Compendium) that the NSO in California also "is subject to a regulatory system that protects against mortality while providing high quality nesting, foraging, and roosting habitat that moves across the landscape over time" because I was not tasked with evaluating the efficacy of California's timber harvesting regime in conserving NSO. Having said that, from my prior involvement with NSO studies, including those of Forsman et al, it is obvious that California's regime for the regulation of timber harvesting has shown itself to be significantly more effective in conserving NSO than those of its sister states. The data are saying that the California regulators and timberland owners and operators are doing a lot of the right things for NSO conservation on private timberlands in California; in other words, the data support an inference of the efficacy of that regulatory regime.

EXHIBIT A

Kenneth P. Burnham

22 October 2012

Retired from being Statistician, and Senior Scientist
USGS, Biological Resources Discipline
Colorado Cooperative Fish and Wildlife Research Unit
201 Wagar Bldg
Colorado State University
Fort Collins, Colorado 80523

EDUCATION

Undergraduate:	B.S.,	Portland State University, Biology, 1960-1966
Graduate:	M.S.,	Oregon State University, Statistics, 1966-1969
	Ph.D.,	Oregon State University, Statistics, 1969-1972

PREVIOUS POSITIONS

Laboratory Technician, Department of Microbiology, University of Oregon Medical School, 1963-1965 (Portland, Oregon).
Mathematical Statistician, Institute of Northern Forestry, U. S. Forest Service, 1972-1973 (Fairbanks, Alaska).
Statistician, Migratory Bird and Habitat Research Lab, U. S. Fish and Wildlife Service, 1973-1975 (Laurel, Maryland).
Biometrician, Western Energy and Land Use Team, U. S. Fish and Wildlife Service, 1975-1983 (Fort Collins, Colorado).
Area Statistician, USDA-Agricultural Research Service, South Atlantic Area, from August, 1983 until September, 1988 (Raleigh, North Carolina).
Then 21 years in the Colorado Coop-Unit:
Assistant Unit Leader, Colorado Cooperative Fish and Wildlife Research Unit, (Fort Collins, CO) since September, 1988. The Units were under the U.S. Fish and Wildlife Service from their inception in 1935 until late 1993. November 13, 1993 the Units, hence my position, was transferred to the newly created National Biological Survey agency within USDI. Later, the name was changed to National Biological Service. The on October 13, 1996 all of NBS was eliminated as a free-standing agency by being merged with the US Geological Survey as a fourth division within USGS: then Biological Research Division (BRD); now called Biological Resources Discipline. August 8, 2004 I was promoted to Senior Scientist.

PRESENT POSITION

Emeritus professor at CSU, and independent consultant.

ACADEMIC APPOINTMENTS

Adjunct faculty, as assistant professor of statistics, University of Alaska (Fairbanks), 1972-1973 academic year.
Affiliate faculty, Department of Fisheries and Wildlife, Colorado State University, 1978-1982 academic years.
Associate Professor (USDA), Statistics Department, North Carolina State University, 1983-1988 academic years.
Faculty, Department of Fishery and Wildlife Biology, and affiliate faculty Department of Statistics, Colorado State University, since September 1988 through December 2008.

See my vitae information "***Academic***" for information on courses taught and students mentored.

AWARDS AND FELLOWSHIPS RECEIVED

See my vitae information "***Awards, honors and special activities.***"

PROFESSIONAL SOCIETIES

American Statistical Association (since 1967; lifetime member since 2009)
The International Biometric Society (since 1968)
Institute of Mathematical Statistics (since 1973; lifetime member since 2011)
International Statistical Institute, elected member (since 2007)
The Wildlife Society (since 1978; lifetime honorary member since 2011)
Ecological Society of America (1990-2001)

On the Editorial Board of the Ecological Society of America, Oct. 1, 1989 to Dec. 31, 1992; basically, this meant being an associate editor of the journals Ecology and Ecological Monographs, hence making the accept/reject decision on manuscripts assigned to me by the Managing Editor.

Associate Editor of Biometrics from May 1997 to Jan. 2000.

Elected to the Regional Committee of the Western North American Region (WNAR) of the International Biometric Society (IBS) for 2004-2006.
President-elect of WNAR for 2006.
President of WNAR in 2007.
Past-President of WNAR in 2008.

RESEARCH INTERESTS

Design of studies for sampling biological populations, especially for estimation of population abundance and population dynamics parameters.

Statistical inference methods for ecological, wildlife, and fisheries studies, and data-based modeling of biological processes, including model selection and assessing model selection uncertainty. Some specifics:

Dynamics of exploited populations, especially the question of additivity of exploitation and natural mortality.

The effect of heterogeneity in population dynamics (models), population sampling (i.e., size-biased sampling in ecology), and data analysis.

Theory and application of release-resampling (i.e., capture-recapture) studies.

Ecological experiments utilizing release-recapture methodologies.

Estimation of parameters from bird banding studies.

Theory and application of distance sampling (line and point transects) of wildlife and plant populations.

Closed-model capture-recapture theory.

Open-model capture-recapture theory.

Statistical design of environmental biotic studies.

Model selection in population parameter estimation, especially using AIC in capture-recapture.

Applied population sampling in natural resources based on finite population sampling theory.

Theory and application, in general, of information theoretic (e.g., AIC) model selection.

SEE ALSO
Publications
Awards, honors and special activities
Academic
Meetings

Kenneth P. Burnham
Publications

17 March 2014

Burnham, K. P. and W. S. Overton, 1969. A simulation study of livetrapping and estimation of population size. Technical Report 14, Dept. of Statistics, Oregon State University (69 pages plus Appendix tables and figures).

Burnham, K. P. 1972. Estimation of population size in multiple capture-recapture studies when capture probabilities vary among animals. Ph.D. Dissertation,Oregon State University, Corvallis, Oregon.

Cushwa, C. T. and K. P. Burnham, 1974. An inexpensive live trap for snowshoe hares. Journal of Wildlife Management 38(4):939-941.

Krohn, W. B., F. W. Martin and K. P. Burnham, 1974. Band-recovery distribution and survival estimates of Maine woodcock. Proceedings of the Fifth American Woodcock Workshop (held December 3-5, 1974, Athens, Georgia) (8 pages).

Henny, C. J. and K. P. Burnham, 1976. A reward band study of mallards to estimate band reporting rates. Journal of Wildlife Management 40(1):1-14.

Henny and Burnham (1976) was reprinted, Pp 517-536, in Ratti, J. T., L. D. Flake, and W. A. Wentz (eds.), 1982. Waterfowl ecology and management: selected readings. The Wildlife Society, Bethesda, Maryland.

Burnham, K. P. and D. R. Anderson, 1976. Mathematical models for nonparametric inferences from line transect data. Biometrics 32(2):325-336.

Anderson, D. R. and K. P. Burnham, 1976. Population Ecology of the Mallard VI. The effects of exploitation on survival. U. S. Fish and Wildlife Service, Resource Publication 128 (66 pages).

Anderson, D. R., J. L. Laake, B. R. Crain and K. P. Burnham, 1976. Guidelines for line transect sampling of biological populations. Utah Cooperative Wildlife Research Unit, Utah State University, Logan, Utah (28 pages).

Brownie, C., D. R. Anderson, K. P. Burnham and D. S. Robson, 1978. Statistical inference from band recovery data—a handbook. U. S. Fish and Wildlife Service. Resource Publication 131 (212 pages).

Anderson, D. R., K. P. Burnham and B. R. Crain, 1978. A log-linear model approach to estimation of population size using the line-transect sampling method. Ecology 59(1):190-193.

Crain, B. R., K. P. Burnham, D. R. Anderson and J. L. Laake, 1978. A Fourier series estimator of population density for line transect sampling. Utah State University Press, Logan, Utah (25 pages).

White, G. C., K. P. Burnham, D. L. Otis and D. R. Anderson, 1978. User's manual for program capture. Utah State University Press, Logan, Utah (40 pages).

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IN REVISION

(none)

MANUSCRIPTS IN PREPARATION

Burnham, K. P., and D. R. Anderson. (201x). Comments on Bayesian multimodel inference: True models and priors. Draft done as of 23 March 2014.

IN LIMBO

Andelt, W. F., K. P. Burnham, and P. M. Lukacs. (in limbo). Extinction and colonization of plots by white-tailed and Gunnison's prairie dogs. Perhaps JWM. (depends on Andelt – he retired)

Andelt, W. F., K. Kunek, and K. P. Burnham (in limbo). Combining telemetry and capture-recapture to estimate population size of island fox. (or Population size of the San Clemente Island fox). a draft done in May, 2010; waiting on more data from summer 2010. Intended for Journal of Wildlife Management. (depends on Andelt – he retired)

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April 30, 2014

California Department of Fish and Wildlife
Nongame Wildlife Program
Attn: Neil Clipperton
1812 9th Street
Sacramento, California 95811

RE: Comments for the status review of the Northern Spotted Owl (*Strix occidentalis caurina*).

Dear Neil Clipperton,

This letter is to provide information for the status review of the NSO pursuant to the Fish and Game Code section 2074.4 to solicit data and comments on the petitioned action. I have reviewed the report titled "Evaluation of the petition from the Environmental Protection Information Center to list the Northern Spotted Owl (*Strix occidentalis caurina*) as threatened or endangered under the California Endangered Species Act" (CDFW 2013).

Point Blue Conservation Science (formerly PRBO Conservation Science) is a non-profit conservation organization with the mission to advance conservation of birds, other wildlife, and ecosystems through science, partnerships, and outreach. We have been studying the Northern Spotted Owl (NSO; *Strix occidentalis caurina*) in Marin County since 1997.

We encourage the CDFW to review our recent report and two peer-reviewed manuscripts concerning NSO in Marin County (copies included with this letter). The report is our 2013 annual report from NSO monitoring on Marin Municipal Water District and Marin County Open Space District lands (Cormier 2013). We have been monitoring NSO on these public lands, and adjacent areas with the objectives of monitoring long-term trends, and helping to ensure that disturbance to nesting owls is avoided. We have annual reports from our surveys since monitoring efforts began; please feel free to contact me if earlier reports would be useful. The first manuscript provides results from modeling spatial predictions of nest-site occurrence in Marin County (Stralberg et al. 2009) and the second describes the status and distribution of the Barred Owl (*S. varia*) in Marin County (Jennings et al. 2011).

Finally, all of our data are submitted annually to the California Natural Diversity Database managed by your agency. Please do not hesitate to contact me if you need additional information about these data.

Thank you for the opportunity to provide information for the status review.

Sincerely,

RCorm

Renée Cormier
415.868.0655 ext. 316
rcormier@pointblue.org

cc: Ellie Cohen, President and CEO, Point Blue Conservation Science

Citations

California Department of Fish and Wildlife. 2013. Evaluation of the petition from the Environmental Protection Information Center to list the Northern Spotted Owl (*Strix occidentalis caurina*) as threatened or endangered under the California Endangered Species Act. Report to the Fish and Game Commission.

Cormier, R. L. 2013. Northern Spotted Owl monitoring on Marin County Open Space District and Marin Municipal Water District Lands in Marin County, CA – 2013 Report. Point Blue Conservation Science, unpublished report.

Jennings, S., R. L. Cormier, T. Gardali, D. Press, W. W. Merkle. 2011. Status and distribution of the Barred Owl in Marin County, California. Western Birds 42: 103-110.

Stralberg, D., K. E. Fehring, L. A. Pomara, N. Nur, D. B. Adams, D. Hatch, G. R. Geupel, S. Allen. 2009. Modeling nest-site occurrence for the Northern Spotted Owl at its southern range limit in central California. Landscape and Urban Planning 90: 76-85.

From:	Renee Cormier <rcormier@pointblue.org>
Sent:	Wednesday, April 30, 2014 5:03 PM
To:	Wildlife Management
Cc:	Ellie Cohen; Diana Humple
Subject:	Nothern Spotted Owl
Attachments:	PointBlue_comments_NSO_status_review.pdf; Jennings_etal_2011.pdf; Stralberg_etal_2009.pdf; PointBlue_MMWD_MCOSD_SPOW_report_2013.pdf

Dear Neil Clipperton,

Thank you for the opportunity to provide data and information about NSO in California for their Status Review. I have attached a letter with information on our NSO monitoring project in Marin County, a report from 2013 surveys, and two manuscripts (Jennings et al. 2011, and Stralberg et al. 2009).

Please let me know if you would like additional information, or if you have any questions.

Sincerely,

Renée Cormier

Renee Cormier, *Avian Ecologist*
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April 30, 2014

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STATUS AND DISTRIBUTION OF THE BARRED OWL IN MARIN COUNTY, CALIFORNIA

SCOTT JENNINGS, RENÉE L. CORMIER, and THOMAS GARDALI, PRBO Conservation Science, 3820 Cypress Dr., Suite 11, Petaluma, California 94954; sjennings@prbo.org

DAVID PRESS, National Park Service, Point Reyes National Seashore, 1 Bear Valley Road, Point Reyes Station, California 94956

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ABSTRACT: Marin County, California, is the southern limit of the range of the Northern Spotted Owl (*Strix occidentalis caurina*), listed as threatened by the U.S. Fish and Wildlife Service. The density of the Marin population of the Northern Spotted Owl is unusually high, the population breeds in unique habitat associations, and it is genetically isolated from other Spotted Owl populations. Unlike elsewhere in the Northern Spotted Owl's range, habitat loss to logging is not an issue in Marin County. The Barred Owl (*Strix varia*) has been detected in Marin County only since 2002 and may pose a threat to the Northern Spotted Owl through competition and/or interbreeding. We amassed information on the distribution and abundance of the Barred Owl in Marin County via published literature, by consulting local birders, and primarily through data we obtained during our monitoring of the Northern Spotted Owl in Marin County. Monitoring, continuous since 1996, provides an opportunity for an evaluation of the effect of the Barred Owl invasion on the Northern Spotted Owl there. We estimate the county's current population of the Barred Owl at four to seven individuals, including one territorial pair and a single territorial male. We documented two nestings, with four young fledged. Two pairs of the Northern Spotted Owl have been displaced from territories. These results are of concern for an otherwise stable population of the Northern Spotted Owl.

The Barred Owl (*Strix varia*) began expanding its range from eastern North America into western provinces and states in the late 1800s, arriving in the northern portion of range of the Northern Spotted Owl (*Strix occidentalis caurina*) by 1950 (Livesey 2009). The Barred Owl has subsequently expanded west and south through British Columbia, Washington, Oregon, and northern California, to occupy the Northern Spotted Owl's entire range (Gutiérrez et al. 2007).

A growing body of theoretical and empirical work predicts and documents the effects of the Barred Owl on both the Northern and California (*S. o. occidentalis*) Spotted Owls. Displacement and direct competition for food and space are thought to be the largest threats to the Northern Spotted Owl (Kelly et al. 2003, Crozier et al. 2006, Gutierrez et al. 2007). The Barred Owl also interbreeds with (Hamer et al. 1994, Haig et al. 2004, Kelly and Forsman 2004), and possibly preys upon, both the Northern and California Spotted Owls (Leskiw and Gutiérrez 1998). In much of its range the Northern Spotted Owl continues to decline despite federal protection, and the Barred Owl was identified as a major threat in the 2010 draft revised recovery plan for the Northern Spotted Owl (USFWS 2010).

Across most of its range, the Northern Spotted Owl inhabits mature, relatively undisturbed coniferous forests with a closed canopy (Gutierrez et al. 1995). In contrast, where the two species are sympatric, the Barred Owl uses a wider range of habitat types including regenerated coniferous and deciduous forests, areas of lower elevation and flatter topography, and areas of human use and occupation (Hamer et al. 2007, Livesey 2007, Livesey and Flemming 2007). This broader niche may facilitate the Barred Owl outcompeting the Spotted (Livesey and Flemming 2007). Interestingly, in Marin County the Northern Spotted Owl occupies not only mature coniferous forest but second- and third-growth coniferous and broadleaf forests and areas along the urban–wildland interface (Stralberg et al. 2009). While the size of Marin County's Spotted Owl population is not known, surveys of much of the suitable habitat on public land, completed in 1999 before the Barred Owl's arrival, revealed the Spotted Owl at 83 distinct sites, with 53 of these occupied by pairs (Press et al. 2011).

We describe the Barred Owl's colonization of Marin County, estimate its population size, report known attempts at breeding, describe interactions between the Barred and Spotted Owls, and discuss the Barred Owl's invasion in the context of the unique attributes and threats to the Marin population of the Northern Spotted Owl.

METHODS

Data for this study were gained primarily through the detection of Barred Owls during monitoring of the Spotted Owl on land managed by the federal and county governments. Widespread monitoring in Marin County by the National Park Service and PRBO Conservation Science began in 1996, though some limited surveys began in 1993. Inventories (1996–1999 and 2006) and demographic monitoring (1999–present) followed standard protocols (USFWS 1992), modified to minimize the practice of calling and feeding mice to owls while increasing visual searching, in order to reduce the owls' habituation to people (Press et al. 2010). Mimicking owl calls with the human voice or playing calls with electronic devices are widely used for locating Spotted Owls, and live mice are often presented to Spotted Owls to determine the birds' nesting status or nest location (USFWS 1992).

We obtained additional data from local experts Ryan DiGaudio, Jules Evens, Keith Hansen, Steve N. G. Howell, Dave MacKenzie, W. David Shuford, and Rich Stallcup. Additionally, we searched the North Bay Birds e-mail list-serve (http://groups.yahoo.com/group/northbaybirds), eBird (www.ebird.org), *North American Birds* since 1994, and Christmas Bird Count data since 2001 for Barred Owl observations.

We evaluated the observations to determine the birds' sex, age, and numbers. We identified the birds' sex by voice whenever possible. Individuals observed visually were often distinguished as adult or subadult (1 to 2 years old) by the shape and color of the tips of the central rectrices (Moen et al. 1991, Pyle 1997). We estimated the population's upper limit by tallying the number of locations where Barred Owls were detected in a given year and adding individuals where appropriate when multiple birds were observed together. We estimated the lower limit by evaluating the geography, habitat, and distance between locations of detection to consider if observations at different locations may have represented the same individual.

We used GPS receivers to record locations of Barred Owls detected during Spotted Owl monitoring. For Barred Owls for which the observer provided no coordinates, we mapped the location in ArcView 3.2 from the observer's description of the site.

RESULTS

Barred Owls were detected on at least 107 occasions between April 2002 and August 2010, primarily in the southern and western portions of Marin County (Figure 1). Of these detections, 67 were the result of Spotted Owl monitoring, 10 were from the list-serve, 4 were from eBird, 23 were from direct communication with local birders, and 3 were our observations made outside Spotted Owl monitoring. Additional observations, for which specific dates were not recorded, were made in Muir Woods National Monument, Olema Valley, and to a lesser extent near Point Reyes Station. We did not map observations lacking dates, but because Barred Owls were observed frequently in these areas, these individuals are likely represented by the other detections on the map.

Barred Owls have been observed at Muir Woods every year since the county's first record there in 2002, and they have been observed yearly since 2004 in the southern Olema Valley. Barred Owls were detected near Point Reyes Station in 2003, 2005, and yearly from 2008 to 2010, and in Mill Valley in 2009 and 2010. They have also been detected at several other locations across the southern and western parts of the county (Figure 1), though never in consecutive years. All of these locations, except Point Reyes Station, are also occupied by Spotted Owls.

A male and female Barred Owl were detected together in 2005 in Olema Valley, without evidence of nesting. In 2006 a male and female were detected in Muir Woods, again with no evidence of nesting. In 2007, a pair and two fledglings were found together in Muir Woods, but the nest was not located. In 2008, a nest was found in Muir Woods, both parents were confirmed as Barred Owls, and two young fledged. In 2008, a subadult Barred Owl was detected in Muir Woods, and in 2009 one was found in Mill Valley, 1.2 km from Muir Woods.

We estimate that as of August 2010 there were between four and seven Barred Owls within Marin County (Figure 2), including a territorial pair at Muir Woods, a territorial male in Olema Valley, one to two individuals around Point Reyes Station, and one or two in Mill Valley, though there may be some overlap between this site and Muir Woods.

In Marin County, more individual Barred Owls have been identified as males than as females, and only one pair has been found in any year, possibly implying a male-biased population. In many sightings, however, the bird's sex was not determined (see below regarding limitations of our data), so the true sex ratio of the population is not known. Barred Owls were classed as subadult on only two occasions, and these may represent different detections of the same bird. In spite of the number of birds of unknown age, the Marin Barred Owl population appears to be composed primarily of adults.

Hybrid Barred × Spotted Owls have not been conclusively identified in Marin County. But Jules Evens and Rich Stallcup (pers. comm.) reported

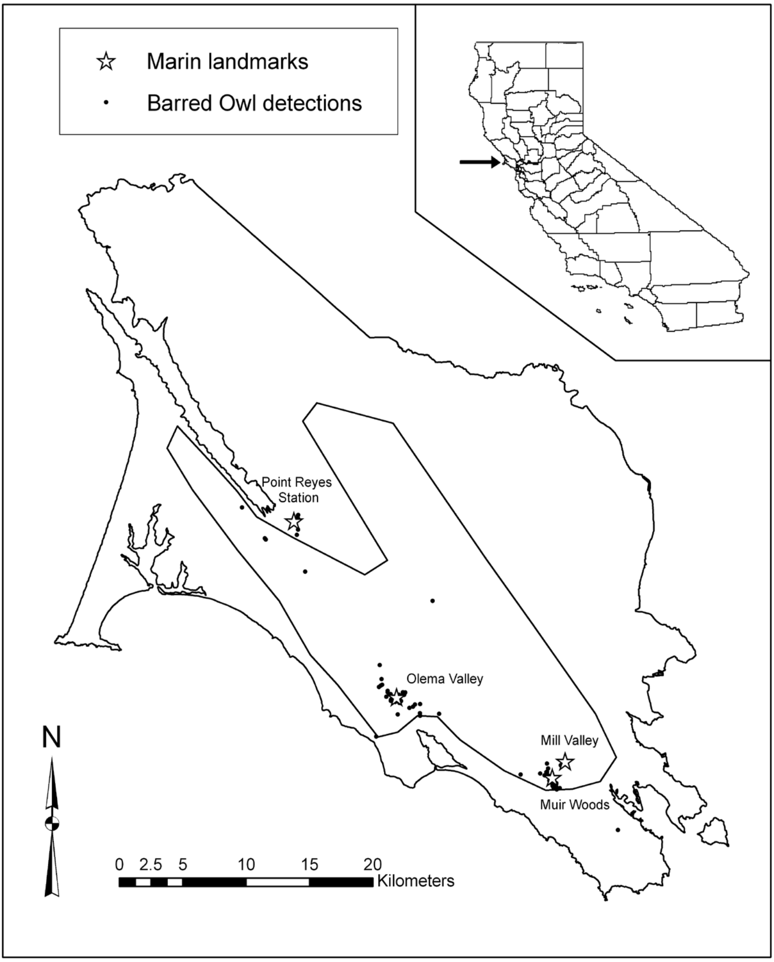

Figure 1. Locations in Marin County, California, of 89 Barred Owl observations (circles) for which specific dates and locations were recorded, 2002–2010. Stars mark the locations of landmarks referred to in the text, and the study area outline shows land covered by surveys monitoring the Northern Spotted Owl.

hearing calls intermediate between those of the Spotted and Barred near Point Reyes Station in the falls of 2005, 2006, 2007, and 2010. For example, Stallcup reported hearing a call that started with the first three notes of the Spotted Owl's standard four-note call but then proceeded into the caterwauling ending characteristic of the Barred Owl. Evens noted that he could not confidently identify the owl as Barred, but he was sure it was not a pure Spotted. Via the list-serve, Ken Burton also reported an unidentifi-

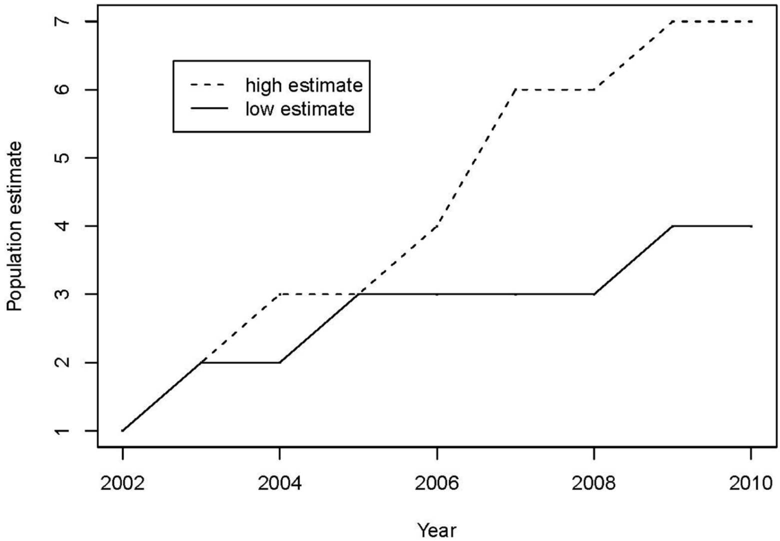

Figure 2. Estimates of the population of the Barred Owl in Marin County, California, 2002–2010. Dashed line, maximum number estimated; solid line, minimum number estimated.

able call of *Strix* in Mill Valley. In all these cases, the owl making the calls was not seen.

On multiple occasions Barred and Spotted Owls were heard calling in the same vicinity, but the extent of interaction is not known. On three daytime surveys, we and other biologists observed notable interactions between the two species: (1) both members of a pair of Spotted Owls charged and dove at a Barred Owl, (2) a Barred Owl chased a female Spotted Owl, and (3) an aerial "clash" between a Barred and a Spotted Owl.

In Muir Woods Barred Owls were observed foraging during daylight hours, hunting for crayfish (*Pacifastacus* spp.) in a stream on multiple occasions and foraging while walking on the ground.

DISCUSSION

The Barred Owl population in Marin County is currently small but well established, and it has continued to grow steadily since the species was first detected in 2002. Two home ranges have been established, one in Muir Woods and one in Olema Valley. In 2007 and 2008, Barred Owls successfully fledged two young each year from nests in Muir Woods. The 2007 Barred Owl nest is of particular interest because in that year only two of 37 monitored Spotted Owl pairs attempted nesting. Barred Owls may nest more often and produce more offspring per nesting attempt than the Northern Spotted Owl (Livesey and Fleming 2007, Wiens et al. 2009).

Hybridization between the two species in Marin County appears to be low or none; no mixed pairs have been observed, and no hybrids have been confirmed. Hamer et al. (1994) predicted hybridization to be more likely in the early stages of Barred Owl invasion, because there are few Barred Owls to make single-species pairs, but they also noted that isolating mechanisms between the two species are likely to keep hybridization to a minimum.

Our estimate of the Barred Owl's population in Marin County is conservative. The Barred Owl may not be sampled adequately by Spotted Owl monitoring (Livesey and Fleming 2007). Additionally, while most of the habitat suitable for the Spotted Owl on public land in Marin County is well covered through demographic monitoring, the Barred Owl has been detected in other habitats within the county, such as riparian. Last, little is known about the Barred Owl's occurrence on private lands. Uneven detectability and spatial distribution by sex or age class may have influenced our estimates of population size. However, given the extent and effort of Spotted Owl monitoring and of general bird watching in Marin County, we feel confident that the majority of Barred Owls present have been detected.

The presence and increasing abundance of Barred Owls at the southern limit of the Northern Spotted Owl's range in Marin County is troubling. The Marin County population of the Northern Spotted Owl may be an especially important one because it is geographically and genetically isolated from both the Northern Spotted Owl farther north in northern California and from the California Spotted Owl in the Sierra Nevada and in southern California (Barrowclough et al. 2005). Additionally, in Marin the population density of breeding Northern Spotted Owls is higher than elsewhere, the population's fecundity is consistently high, and the population uses a wider variety of habitats than does the Northern Spotted Owl in other areas (Anthony et al. 2006, Stralberg et al. 2009). Finally, the traditional threat of habitat loss and degradation due to logging is nonexistent in Marin County, and the existing pressures there (e.g., recreation, noise disturbance, urban encroachment, rodenticide use, increased risk of human-caused wildfire) have not been severe enough to cause population declines. The Marin population appears to be stable (Stralberg et al. 2009, Jensen et al. 2010).

Our early observations suggest that the Barred Owl may be affecting the Northern Spotted Owl in Marin County in ways similar to those reported elsewhere, including displacement and potential suppression of the Spotted Owl's response to mimicked calls (Kelly et al. 2003). In Muir Woods a single pair of Barred Owls now occupies the core area where two pairs of the Spotted held territories prior to the arrival of the Barred. Both pairs of the Spotted appear to have relocated to nearby areas. Additionally, the Spotted Owls have become more difficult to detect in Muir Woods and Olema Valley since the Barred Owl's arrival. In Marin, Barred Owls have been observed exploiting a diet (including crayfish) more diverse than the Spotted's, and the nesting in 2007 suggests higher fecundity. Both of these factors are thought to facilitate the Barred Owl outcompeting the Spotted (Livesey and Flemming 2007). Currently, Barred Owls occupy a small number of Spotted Owl territories and to date appear to affect individuals rather than the entire Marin population of the Spotted Owl.

The effect of the Barred Owl on the Northern Spotted Owl in Marin County is cause for concern. We recommend continued monitoring of the Spotted Owl throughout Marin County, the addition of surveys designed to improve detection of the Barred Owl, and that citizen scientists report Barred Owls sightings vigilantly.

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Point Blue Conservation Science

Northern Spotted Owl Monitoring on Marin County Open Space District and Marin Municipal Water District Lands in Marin County, CA

2013 Report

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INTRODUCTION

The Northern Spotted Owl (NSO; *Strix occidentalis caurina*) is a year-round resident found primarily in older, coniferous forests from southern British Columbia to Marin County, California. The NSO was listed by the U.S. Fish and Wildlife Service (USFWS) as a Federally Threatened subspecies in 1990, with declines mostly attributed to habitat loss. After more than two decades on the Endangered Species list, the NSO is still declining in many parts of its range (Forsman et al. 2011, USFWS 2011). While current and past habitat loss remains a major threat, the range expansion of the Barred Owl (*Strix varia*) also poses a very considerable and complex threat to the NSO (Gutiérrez et al. 2007, USFWS 2011, Wiens 2012). NSO in Marin County are not impacted by commercial tree harvesting operations as in other parts of their range, but they face other unique threats including urban development, human disturbance due to construction and/or recreational activities, noise disturbance, pesticide poisoning, risk of wildfires along the urban-wildland interface, and genetic isolation (Stralberg et al. 2009). Additionally, while the invasion of Barred Owls in Marin County has not yet reached the high densities as in other parts of the NSO range (Jennings et al. 2011), a continued increase in Barred Owl numbers could pose a serious threat to the NSO population in Marin (e.g., Forsman et al. 2011, Wiens 2012).

Since 1997, biologists from Point Blue Conservation Science (formerly PRBO; hereafter Point Blue) have been monitoring NSO in Marin County. Marin County Open Space District (MCOSD) and Marin Municipal Water District (MMWD) have contracted Point Blue to survey NSO since 1999. Surveys are primarily on MMWD and MCOSD lands, but also include sites on private, municipal, state, and national park lands that are adjacent to MMWD and MCOSD lands. The purpose of these surveys is to monitor the population over time (trends and reproductive success). In addition, at other sites where proposed management activities may occur, biologists from Point Blue have been conducting NSO surveys to determine occupancy and nesting status so that disturbance to nesting birds is avoided.

In 2013, Point Blue biologists continued to monitor occupancy, nesting, and reproductive status for known historic NSO activity centers on or adjacent to MMWD and MCOSD lands. We also conducted inventory surveys at new locations based on management plans. In this report, we present a summary of results for 30 historic sites and 8 inventory areas.

METHODS

Surveys in 2013 followed the recently-updated USFWS protocol (USFWS 2012). The updated protocol reflects the best available information for detecting NSO in the presence of Barred Owls, and doubles the number of surveys needed before a site can be classified as unoccupied by NSO. We also used the USFWS protocol (2012) for nesting and reproductive surveys, but whenever possible we attempted to gather nesting and reproductive information without the use of mice, per the modified protocol for surveying NSO in Marin County (Press et al. 2010). The modified protocol attempts to minimize “mousing” owls to avoid habituating NSO to being fed by humans since the owls are often in close proximity to humans and heavily-used trails and roads in Marin County. For sites with planned management activities (e.g., noise disturbance), we conducted mousing surveys if nesting status could not be determined without the use of mice by early April. All 2013 surveys were led by Renée Cormier and Suzanne Winquist of Point Blue from March to July.

We surveyed a total of 30 historic sites on or adjacent to MCOSD and MMWD land. Most sites were chosen based on knowledge of NSO occurrence in previous years, and sites were prioritized where management activities were planned. In addition, we surveyed 8 inventory areas based on management needs (Table 1). We assessed occupancy, nesting, and reproductive status at all historic and inventory sites. We completed site search forms and maps for all fieldwork, status forms for each site, and vegetation measurements for nest trees. All data, including GIS, will be submitted to MCOSD, MMWD, and to the California Department of Fish and Wildlife’s California Natural Diversity Database (CNDDB).

A site is considered unoccupied after 2 years of surveys with 6 nighttime visits each year with no owl response (USFWS 2012). For sites surveyed for disturbance projects only (as opposed to planned habitat modification), 6 visits with no response in one year is sufficient to call a site unoccupied until the start of the next breeding season (USFWS 2012). In this report, I classify any site with no response in 2013 as unoccupied, but specify whether it was unoccupied for one or two years.

For sites where owls are detected, determination of residency status followed USFWS protocols and is summarized as follows (for more details see USFWS 2012): Pair = male and female heard within 0.25 miles on the same survey, and/or nesting is confirmed; Resident Single = response by a single owl on three or more occasions, with no response by an owl of the opposite sex; Unknown = male and/or female detected, but did not meet the above criteria. The Marin protocol (Press et al. 2010) has an additional status designation, Single Unknown, used when a single owl is detected but does not meet the above status categories (excluding Unknown status).

Fecundity is defined here as the total number of female young per territorial female. Fecundity was calculated by dividing the total number of young produced by 2 (assuming a 1:1 sex ratio of young), and then dividing by the total number of territorial females (paired females and resident single females). This method is commonly used with NSO data and can be compared across studies (e.g., Anthony et al. 2006, Forsman et al. 2011). We excluded survey results from 1999 in the fecundity estimate, since very few sites were surveyed that year.

RESULTS

Occupancy at inventory sites. NSO were detected at most of inventory areas (Table 1), but owls were usually not detected on more than one or two visits, therefore not meeting “resident” status. The exception was a Lakeview Fire Road, where a single male was detected on 3 surveys, thus meeting “resident single” status. Two inventory sites were designated as unoccupied.

Occupancy at historic sites. Of 30 historic sites, 27 (90%) were occupied by pairs (Table 2). West Peters Dam was the only unoccupied historic site. This is the first time since 1997, when West Peters Dam was first surveyed, that the site was not occupied by a pair of NSO. Whites Hill was occupied by a resident single male this year, and a single male of unknown resident status was detected at Soulajule Reservoir. This is the first time Whites Hill has not been occupied by a pair since initial surveys in 2003. Soulajule was unoccupied in 2010, but otherwise has been occupied by a pair since it was first surveyed in 1999.

Nesting and reproduction. Of the 27 sites with pairs, 10 (37%) pairs nested, 15 (56%) pairs were confirmed as non-nesting, and 2 (7%) sites were of unknown nesting status (Table 2). Of 10 nesting pairs, 8 (80%) were successful (fledged at least 1 young) but fecundity was below the study average for the second year in a row (Figure 1).

Overall. No Barred Owls were detected during 2013 surveys. No color-banded individuals were detected; however, we did not see the legs of the female at Arroyo Corte Madera and from 2004 to 2012, there was a banded female at this site.

Table 1: Inventory surveys conducted in 2013.

Inventory Route	Description	Sites within Inventory Route	SPOW Status
Jewell Trail	GGNRA[1]/NPS[2] land; culvert replacement (MMWD) & road paving project (by the DPW[3])	Jewell Trail	**Single Unknown**: male detected on two surveys
Lagoon Fire Road	MMWD – planned trail decommission	Arturo Trail, Hidden Lake	**Arturo Trail (Single Unknown)**: male detected on 1st of 6 visits - no other detections; **Hidden Lake (Unknown)**: male and NSO of unknown sex on 3rd of 6 visits - no other detections
Lakeview Road	MMWD – planned fire break	Lakeview Road	**Resident Single**: male detected on 3 of 7 night surveys
Loma Alta	MCOSD - inventory, no management planned	Loma Alta	**Unknown**: NSO of unknown sex detected on 6th of 8 night surveys
Lower Summit	MCOSD - annual roadside mowing by Mill Valley Fire Dept	Lower Summit	**Unoccupied (year 1; 2013 only)**: 6 night surveys with no NSO detected
Madera Park Tank	MMWD - tank work	Madera Park Tank	**Single Unknown**: male detected on 2 of 8 night visits
Sir Francis Drake	SPTSP[4] - between Pioneer Tree Trail and West Peters Dam; management site for Dept of Public Works only, but in area of interest to MMWD.	Sir Francis Drake	**Unknown**: male and female detected on one survey, single NSO of unknown sex detected on another - no other detections
Upper Laurel Dell	MMWD - brushing project along Laurel Dell from Ridgecrest to Cataract Trail	Upper Laurel Dell	**Unoccupied (year 1; 2013 only)**: 6 night surveys with no NSO detected

[1] GGNRA = Golden Gate National Recreation Area; [2] NPS = National Park Service; [3] DPW = Department of Public Works; [4] SPTSP = Samuel P. Taylor State Park.

Table 2. Status of historic Northern Spotted Owl sites on or adjacent to MCOSD and MMWD land in 2013.

Site Name	2013 Status	Landowner
Arroyo Corte Madera	Pair	MCOSD/Private
Baltimore Canyon	Fledged 1	MCOSD
Bates Canyon	Non-nesting	MCOSD
Bike Path	Non-nesting	NPS[1]
Blake Canyon	Failed Nest	MMWD
Camino Alto	Fledged 1	MCOSD
Cascade Park	Non-nesting	Municipal
East Peters Dam	Non-nesting	MMWD
Fairfax	Fledged 1	Private
Five Corners	Non-nesting	MMWD
Forest Knolls	Non-nesting	MCOSD
Indian Tree	Non-nesting	MCOSD
Indian Valley	Fledged 2	MCOSD
Iron Spring	Non-nesting	MCOSD
King Mountain	Fledged 1	MCOSD
Lagunitas	Failed Nest	MCOSD
Larkspur	Non-nesting	MCOSD
Phoenix Lake	Fledged 1	MMWD
Pioneer Tree Trail	Non-nesting	SPTSP[2]
Ross	Fledged 1	Municipal
Roy's Redwoods	Non-nesting	MCOSD
San Anselmo Creek	Pair	Private
Shaver Grade	Non-nesting	MMWD
Soulajule Reservoir	Single Unknown	MMWD
Swimming Hole	Non-nesting	SPTSP[2]
Upper Kent Lake	Fledged 2	MMWD
Warner Canyon	Non-nesting	MCOSD
West Peters Dam	Unoccupied (year 1; 2013 only)	SPTSP[2]
White's Hill	Single Male	MCOSD

[1] **NPS** = National Park Service; [2] **SPTSP** = Samuel P. Taylor State Park.
Failed nest = Nesting pair and no young fledged; **Fledged** = Successful nesting pair (fledged $\geq$1 young); **Non-nesting** = Pair confirmed, but non-nesting based on mousing results and/or watching female roost for 60 min (Apr 1-May 1); **Pair** = Male & female confirmed but nesting status not confirmed; **Single Unknown** = A male or female was detected, but the site did not meet resident single status (to meet resident single status, an owl of the same sex must be detected on 3 occasions); **Unoccupied** = 6 night surveys (1 or 2 years – see methods) with no response.

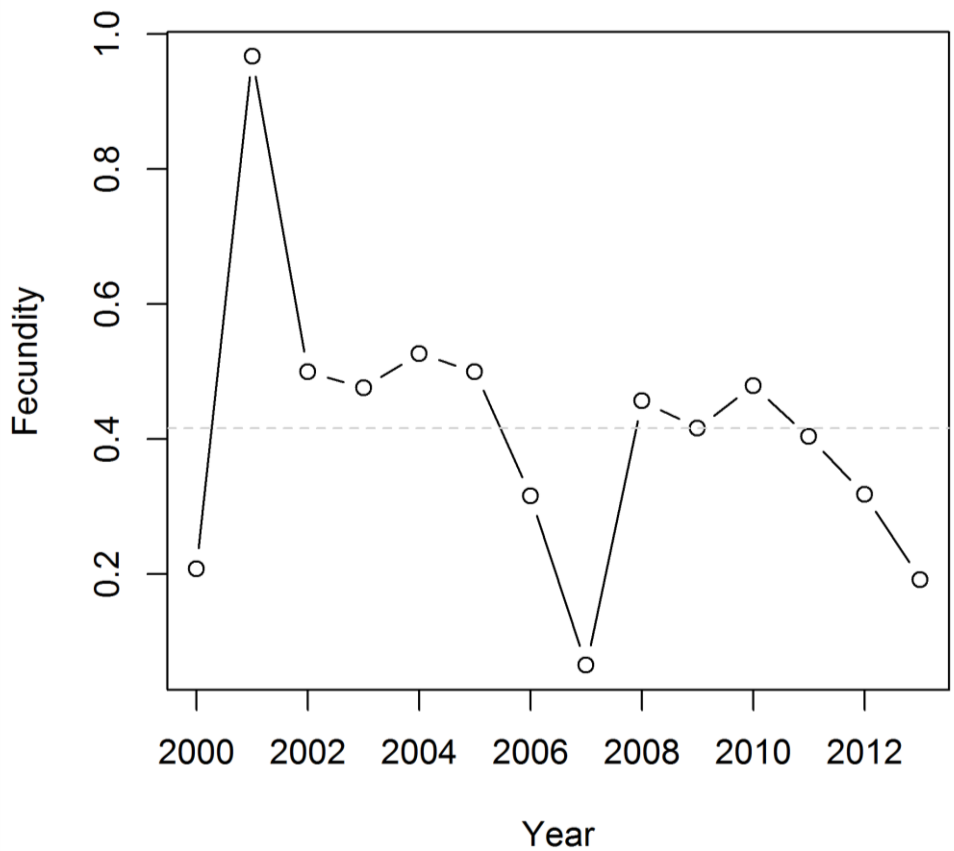

Figure 1. Fecundity (the number of female young produced per territorial female) for Northern Spotted Owls in Marin County on or adjacent to MCOSD and MMWD lands (2000-2013). Sample size varies (from n=9 to n=33) and not all sites were surveyed each year. Study average is shown as a dashed gray line.

DISCUSSION

Occupancy. Ninety percent of historically-occupied sites were confirmed occupied by a pair of NSO in 2013. West Peters Dam was unoccupied for the first time since 1997, when the site was first surveyed. Because NSO are less responsive in the presence of Barred Owls (Olsen et al. 2005, Crozier et al. 2006, Wiens et al. 2011), we also conducted Barred Owl surveys on our last three night surveys, but no Barred Owls were detected. The addition of Barred Owl surveys after the lack of response by NSO is a new optional recommendation in the USFWS (2012) protocol. Surveys should be conducted at West Peters Dam in 2014 to confirm if the site remains unoccupied, or if 2013 was an anomalous year. Whites Hill was occupied by a Resident Single male this year, which is the first time the site has not been occupied by a pair since 2003, when surveys were initiated at the site. Finally, there was a male of unknown resident status at Soulajule; there were no owls detected in the usual NSO drainage at the south end of the reservoir, but instead an owl was detected at the northeast edge of the reservoir near the MMWD ranger house over 1km from the usual drainage.

We surveyed eight inventory sites, and among them, we confirmed two sites as unoccupied (1 year only) and one as occupied by a resident single male. At each of the other five inventory sites, owls were detected on one or two surveys, but may not represent resident owls. However, the detections of NSO in new locations and at sites that are not surveyed each year highlight the importance of NSO surveys in areas with appropriate habitat where proposed management activities are planned. While some of the owls that were only detected on a small proportion of the nights may be transients, they may also prove to be established breeding sites or activity centers if we continue to detect owls at these sites.

Nesting and reproduction. Only 10 of 27 pairs nested in 2013, and of those that nested, most produced only 1 fledgling, resulting in the second lowest fecundity value since 2000. Anthony et al. (2006) determined fecundity to range from 0.306 to 0.560 depending on geographic region; they calculated fecundity on the California coast to be 0.442, similar to our study average in Marin but higher than fecundity at our sites the past two years. Forsman et al. (2011) found that fecundity has declined over time in most parts of the NSO range at long-term study sites, but because fecundity is so variable, models of demographic change were most sensitive to changes (declines) in adult survivorship. While we don’t have a marked population of owls in Marin County to estimate survival, we can estimate trends in occupancy (MacKenzie et al. 2012), and I recommend doing this analysis for the county given the declines in most other parts of the NSO range; plans are in effect for Point Blue and National Park Service staff to collaborate on such an analysis next year.

Barred Owls. No Barred Owls were detecting during NSO surveys on MMWD or MCOSD lands in 2013. The only known pair of Barred Owls in Marin County, at Camp Eastwood, nested successfully and produced two young this year (NPS, unpublished data). This pair has successfully nested in at least five of the last seven years (2007 to 2013), since the pair was first detected. NPS staff also detected one other single Barred Owl in the Olema Valley, but this was not a new Barred Owl location. An increase in Barred Owls may threaten the NSO population in Marin County through competition for space and food (Anthony et al. 2006, Gutiérrez et al. 2007, Wiens 2012). While much still remains unknown about the effects of increasing Barred Owls on NSO, recent studies have found negative associations including on occupancy of nesting territories (Kelly et al. 2003, Olsen et al. 2005 Wiens 2012), fecundity (Olsen et al. 2004, Forsman et al. 2011), and apparent survival (Anthony et al. 2006, Forsman et al. 2011). In Marin County, we are still experiencing relatively low numbers of Barred Owl detections (Jennings et al. 2011, NPS and Point Blue unpublished data), but we predict they will continue to increase based on the pattern of the invasion documented in the northern part of the NSO range. Point Blue will follow the new USFWS-recommended protocol (USFWS 2012) which should increase our ability to detect NSO, if present, and to monitor any changes in the population. Additional surveys specific to Barred Owl may be warranted to increase our detection likelihood of this species (Wiens et al. 2011).

Conclusions. NSO surveys on MMWD and MCOSD lands documented pairs at most historic sites, but with a few notably unoccupied or with single birds. Low nesting and reproductive rates have occurred in the past two years. Monitoring NSO in Marin County during the breeding season is an essential component to evaluating population health and ensuring that management activities do not negatively impact owls. Continued monitoring will help put a low year of reproductive success into context. Frequent communication and cooperation among MMWD, MCOSD and Point Blue staff have been valuable in ensuring that activities that could negatively impact nesting owls are prevented. Project support from MMWD and MCOSD continues to help avoid disturbance to NSO in Marin County.

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Modeling nest-site occurrence for the Northern Spotted Owl at its southern range limit in central California

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ABSTRACT

At the southern end of its range, the Northern Spotted Owl (*Strix occidentalis caurina*) occurs in high densities and nests in a wide range of forest types and ages, exhibiting different foraging and nesting habits than in the northern part of its range. The intensive monitoring of this subspecies on public lands in Marin County, California, combined with the availability of fine-scale geographic information system (GIS) data, provided a unique opportunity to apply and evaluate a habitat-based species occurrence modeling approach at the scale most relevant to local land managers and planning agencies. We used 4 years of breeding owl survey data (1998–2001) and GIS layers representing topographic, anthropogenic, and vegetation-based landscape characteristics to build logistic regression models of owl nest-site occurrence. Models were used to develop spatial predictions of occurrence within the study area and in adjacent ecoregions, which were validated with an independent dataset. We also compared the predictive performance of two vegetation layers differing in their floristic detail and spatial accuracy. The model based on a local vegetation layer generally exhibited better model performance than the model based on the more generic regional layer. Model results indicated that forest connectivity and topographic conditions, rather than forest type or age, were the strongest predictors of nesting owl presence. Predicting outside the original study area was somewhat successful for a coastal ecoregion similar in vegetation and climate, but not better than random for a nearby inland ecoregion, suggesting that locally derived models are necessary to adequately predict nest-site occurrence.

1. Introduction

Predictive spatial models of species-habitat relationships and predicted occurrence — also known as species or habitat distribution models (Guisan and Zimmermann, 2000; Austin, 2002) and resource selection function (RSF) models (Boyce and McDonald, 1999) — can serve as useful tools to identify and prioritize habitat areas for conservation acquisition, management activities, and new field studies. At regional and continental scales, species occurrence models based on climate, topography, and landcover parameters, have been widely used for over a decade (Lindenmayer et al., 1991; Pereira and Itami, 1991; Aspinall and Veitch, 1993; Boyce and McDonald, 1999). Such models are well suited for predicting the potential distributions of a species under current environmental conditions, as well as future climate change scenarios (Peterson, 2001; Pearson and Dawson, 2003). However, species occurrence models based on regional or continental datasets may have limited utility for land managers who need more specific and fine-scaled information about a species' local distribution and relative habitat suitability (Ferrier, 2002). At the local landscape scale, models based on local survey data and variables such as vegetation cover type/structure, habitat fragmentation patterns, and topographic variation, may be more relevant. The recent availability of high-resolution aerial photography and satellite imagery, and resulting detailed vegetation geographic information system (GIS) layers, have facilitated the development of such fine-scale models of species occurrence (Ozesmi and Mitsch, 1997; Loyn et al., 2001; Gibson et al., 2004). Yet one potential drawback of locally derived models is that they may be limited by the spatial extents of the datasets upon which they are based. Floristically detailed, spatially

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accurate vegetation GIS layers may only exist for small areas, often coinciding with publicly owned lands, thereby limiting the ability to extrapolate predictions to nearby areas with poor data coverage. Furthermore, even if coarser GIS layers with larger extents are used, habitat relationships may differ from one region to the next, also limiting the potential for extrapolation (Thogmartin and Knutson, 2006; Osborne et al., 2007). This highlights the importance of assessing the reliability and generality of the models selected, as well as independently validating model predictions.

This study evaluates the utility of locally derived occurrence models for a federally listed subspecies, the Northern Spotted Owl (*Strix occidentalis caurina*, hereafter "owl"), at its southern range limit. The Northern Spotted Owl ranges from southern British Columbia to central California, with the San Francisco Bay marking the southern end of the subspecies' range (Gutiérrez, 1996). The Marin County population is small (~75 individuals) and relatively isolated from the adjacent populations to the north in Sonoma and Napa counties. While the Marin population appears stable, with the highest reported density for the species and consistently high fecundity (Anthony et al., 2006), it faces threats that are primarily associated with its proximity to the greater San Francisco Bay area, including urban development along open space boundaries, intense recreational pressure, and genetic isolation (Barrowclough et al., 2005).

Throughout its range in the Pacific Northwest, the Northern Spotted Owl has been shown to select mature and old-growth stands for nesting and roosting (Forsman et al., 1984; Carey et al., 1990; Hershey et al., 1998), generally preferring areas with less overall forest fragmentation (Lehmkuhl and Rafael, 1993; Hunter et al., 1995; Meyer et al., 1998). Farther south in northwestern California, a shift in prey from flying squirrels (*Glaucomys sabrinus*) to woodrats (*Neotoma* spp.) is thought to lead to notable differences in habitat suitability (Noon and Franklin, 2002), with greater owl use of ecotones between old-growth forest and other vegetation types (Franklin et al., 2000). At the far southern end of the range in central California, however, habitat relationships are less well known, and this area has not been included in regional habitat suitability analyses (Franklin et al., 2000) or distribution modeling (Zabel et al., 2003) for northwestern California. This isolated population is thought to be somewhat anomalous, with the highest reported densities throughout the subspecies' range (Chow, 2001), and nests that have been found in a wide range of forest types and ages (Chow, 2001).

The goal of this paper was to develop and assess the utility of locally derived occurrence (nest-site location) models for the southernmost Northern Spotted Owl population. We accomplished this via several specific objectives: (1) to generate spatial predictions of nest-site occurrence useful to land managers, local governments, and wildlife biologists; (2) to test the models' applicability outside the original study area using independent datasets from less well-studied regions; (3) to identify forest characteristics associated with owl nest-site occurrence at its southern range edge and compare our findings with those from core northern parts of its distribution; and (4) to determine whether the improved accuracy and floristic detail of locally produced GIS vegetation layers results in higher model accuracy (based on independent test data) than more generic statewide vegetation layers.

2. Methods

2.1. Study area

We conducted owl surveys in western Marin County, California, the majority of which is contained in National Park Service (hereafter "park") ownership. Much of the area's commercially viable coniferous forests were logged in the late 1800s through the 1950s (Evens, 1993) and are now re-growing on public lands, creating a mosaic of mature second-growth conifers, uncut hardwoods and a few old-growth conifer stands. Although timber harvest no longer occurs, residential development, combined with cattle grazing, has resulted in a relatively patchy forest distribution and an extensive wildland–urban interface (Radeloff et al., 2005). Within protected parklands, relatively unperturbed forest occurs within a matrix of habitat patches that includes scrub, rangeland and other non-forest habitats.

Forest types used for nesting by the owl include Douglas-fir (*Pseudotsuga menziesii*), coast redwood (*Sequoia sempervirens*), bishop pine (*Pinus muricata*), and mixed hardwood forests comprised of tanbark oak (*Lithocarpus densiflorus*), coast live oak (*Quercus agrifolia*), and California bay laurel (*Umbellularia californica*). The most common forest type, Douglas-fir, has an extensive secondary canopy of California bay laurel and other hardwoods as well as an understory of hazel (*Corylus californica*) and coffeeberry (*Rhamnus californica*).

2.2. Owl occurrence data

We systematically surveyed a nearly contiguous 171 km^2 area covering national parkland (Point Reyes National Seashore and Golden Gate National Recreation Area) and a local water district (Fig. 1) for owl occupancy in 1997 and 1998, using modified standard protocols (Forsman, 1995). Selected nest sites and activity centers (areas where we repeatedly observed consistent occupancy by owl pairs, but no nests were found during the study period) within this core study area were annually monitored from 1998 through 2001. Nest-site locations were recorded with GPS units at 15 m accuracy or greater. Owl pairs typically nested within a few hundred meters of the previous year's nest, or re-used the same nest, and we considered the resulting cluster of nest locations as a single site, randomly selecting 1 year's nest to represent each site.

To construct models for nest-site occurrence, we used 44 occupied sites and generated 88 random point locations, inside the survey area but at least 100 m from all known nest or pair locations (minimum nest distance = 178 m; mean distance to nearest nest = 1023 m). Because owl nests occurred exclusively in forest habitat, random points were also constrained to fall inside forest habitat. Random points were generated in a GIS using ArcView 3.2a (ESRI, 2000) and standard extensions. Because the area had been extensively surveyed, and most pairs were monitored over several years, randomly chosen locations were assumed to represent sites not used for nesting. Although owl pairs often nest at sites more than 100 m apart in subsequent years, we allowed this relatively close proximity for random points to maximize spatial coverage of the study area and to improve our ability to discriminate between sites with similar environmental conditions.

2.3. Nest-site metrics

For each nest and random location, we calculated a suite of point and landscape metrics from GIS layers using ArcView 3.2a (ESRI, 2000) and standard extensions. Point metrics were measured at the specific nest site or random point, while landscape metrics were calculated for circular areas around the points, using overlapping 200-, 400- and 800 m radii. To determine the radii for calculating landscape metrics, we started at 200 m and doubled the radius until we reached a value close to half of the median distance between nest sites (661 m) (see similar methods described in Franklin et al., 2000). Thus, circles of 800 m radius were assumed to be the largest possible without significant overlap between adjacent territories.

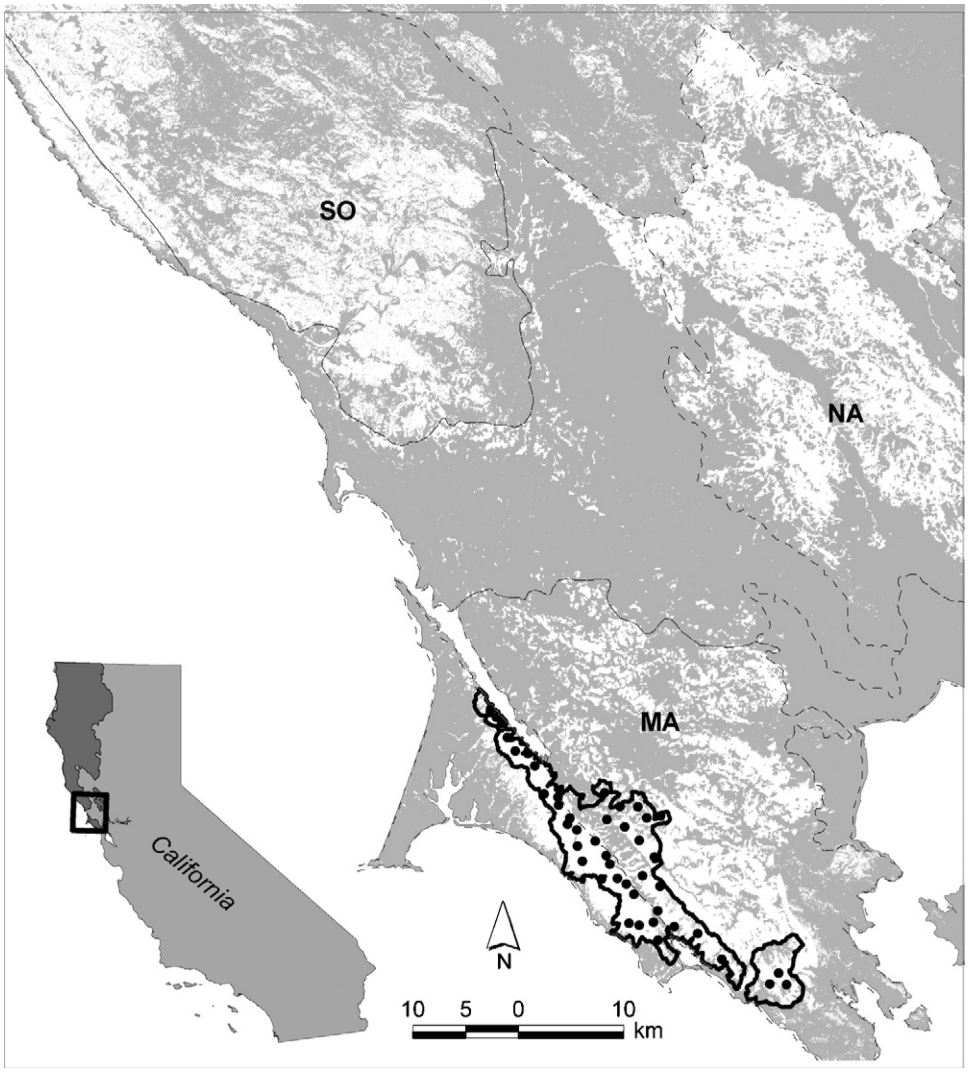

Fig. 1. Marin owl study area exhaustively surveyed in 1997 (bold outline), nest locations (circles), forest cover (white), and subregion boundaries (dashed lines). MA = Marin (263Ak, 263Al); SO = Sonoma (263Ag); NA = Napa (263Am) (Miles and Goudey, 1997). Inset map shows the species' California range.

Nevertheless, there was some overlap between the circles used to calculate landscape metrics for nests and random points: 4639 ha of a 14,543-ha total area for the 800-m radius circles.

Point metrics included south and west aspect (difference between measured aspect, and 180° and 270°, respectively), and distances to the nearest stream and road. Landscape metrics included mean slope, mean elevation, elevational position in watershed ((nest elevation—minimum elevation within a 400-m radius)/total elevation range within a 400-m radius), forest cover proportion, proportion of various vegetation cover types (conifer versus hardwood, and specific dominant tree species), forest stand size class (a proxy for age), and total forest edge (Table 1).

2.4. Vegetation data layers

For model comparison purposes, we calculated all vegetation-related variables from each of two available GIS-based vegetation layers. The first vegetation layer we used was developed by the Point Reyes National Seashore for park-managed areas. It was generated by an intensive mapping process involving the sampling of representative vegetation plots, manual delineation of polygons from 1:24,000 scale true color aerial photos (1994) at a minimum mapping unit of 0.5 ha, and extensive field verification (Schirokauer et al., 2003). Vegetation units were classified at a high botanical resolution following the Manual of California Vegetation (MCV, Sawyer and Keeler-Wolf, 1995). Classification accuracy of general cover types was greater than 80% (Schirokauer et al., 2003). This vegetation layer was combined with a similar vegetation layer for the adjacent water district lands, with vegetation classifications grouped into general cover types. The resulting layer is hereafter referred to as the "local" vegetation layer.

The second vegetation layer used was developed for California forestlands as a joint effort between the U.S. Forest Service and the California Department of Forestry and Fire Protection (1999), and tiled by ecological subregion (Miles and Goudey, 1997). This layer is hereafter referred to as the "regional" vegetation layer. This dataset was developed using an automated classification of 1994 LANDSAT 7 satellite imagery and minimum mapping unit of approximately 1 ha and had no published accuracy assessment. Vegetation types were classified according to the Classification and Assessment with LANDSAT of Visible Ecological Groupings (CALVEG) system (USFS, 1978), which has less floristic detail than MCV.

Both vegetation layers represented conditions in the same year (1994), although they preceded the collection of owl occurrence data (1997–2001). While vegetation was not generally thought to have changed much over that time period, a large area (49 km^2),

Table 1
Names and descriptions of candidate point and landscape variables (200-m, 400-m, and 800-m radius areas around point, denoted with numbers 2, 4, and 8, respectively) used to construct owl nest-site occupancy models, in order of model entry.

Category	Description (units)	Type	Name(s)
Topography	Mean elevation (m)	Landscape	Elevat2-4-8
	Position on slope (proportion)	Point	Shedpos
	Mean slope (degrees)	Landscape	Slope2-4-8
	South aspect (degrees)	Point	Aspectsouth
	West aspect (degrees)	Point	Aspectwest
	Distance to nearest stream (m)	Point	Streamdist
General vegetation	Forested proportion	Landscape	Forest2-4-8
	Conifer proportion	Landscape	Conif2-4-8
	Hardwood proportion	Landscape	Hardwds2-4p-8
Specific vegetation	Douglas-fir (*Pseudotsuga menziesii*) proportion	Landscape	Dougfir2-4-8
	Redwood (*Sequoia sempervirens*) proportion	Landscape	Redwood2-4p-8
	Bishop Pine (*Pinus muricata*) proportion	Landscape	Bishop2p-4p-8
	Coast Live Oak (*Quercus agrifolia*)/Tanbark oak (*Lithocarpus densiflorus*) proportion	Landscape	Oak2p-4p-8
	California Bay Laurel (*Umbellularia californica*) proportion	Landscape	Bay2p-4p-8
	Riparian proportion	Landscape	Riparian2-4-8
	Shrub proportion	Landscape	Shrub2-4-8
	Grass proportion	Landscape	Grass2-4-8
	Urban proportion	Landscape	Urban2-4-8
Forest stand maturity	Mean size class (1-5)	Landscape	Whrsize2-4-8
Forest fragmentation	Total forest edge length (m/ha)	Landscape	Edgelength2-4-8
	Distance to nearest road (m)	Point	Roaddist

containing two random points (but no owl nests through 2007), was burned in a stand-replacing fire in 1995 (Ornduff, 1998; Fellers et al., 2004).

2.5. Model selection

For each variable of specific interest (Table 1), we compared the means and standard deviations of nest locations (occupied sites) and random points (presumed unoccupied) for descriptive purposes. For landscape variables, we compared across the three radii examined (200, 400, and 800 m). We also evaluated the influence of each variable on nest presence/absence using logistic regression analysis (Hosmer and Lemeshow, 2001).

For 44 nests and 88 random points, we then constructed logistic regression models to predict nest-site occurrence using Stata 8.0 (StataCorp, 2003). Logistic regression has been described as inappropriate for modeling habitat selection in use-availability studies where areas of non-use are unknown (Keating and Cherry, 2004). However, the complete coverage of our surveys meant that we were able to use data from nearly an entire population (as opposed to a sample), such that non-use areas were well known. Logistic regression is thought to perform well with presence-only data collected using comprehensive survey strategies such as ours (Wintle et al., 2005).

For each vegetation layer (local and regional), we developed models using a hierarchical approach to variable selection, based on the hypothesized relative importance of each category of variables (Table 1, in order from top to bottom) using the radii for which the univariate relationships in logistic regression models were most significant. For each successive variable added to the model, we used a likelihood ratio statistic (Hosmer and Lemeshow, 2001) to evaluate whether the variable should be retained in the model ($\alpha = 0.05$). We hypothesized that physical topographic characteristics (e.g., slope position, aspect) would have the largest influence on nest-site location, followed by general forest composition (conifer/hardwood proportion), specific forest types (e.g., Douglas-fir, Coast Redwood) and surrounding non-forest vegetation types (e.g., shrub, grassland), forest stand maturity (size class), and forest fragmentation (forest edge length and distance to nearest road).

We compared Akaike's Information Criterion (AIC) (Akaike, 1974) and Receiver Operating Characteristic (ROC) plot area under the curve (AUC) values (Fielding and Bell, 1997) from each of the resulting two models to evaluate model fit and suitability. We also compared the percent of sites correctly classified as occupied or unoccupied by each model, using the probability cut-off that maximized model sensitivity (percent of actual occupied sites identified by the model) plus specificity (percent of model-predicted occupied sites that were actually occupied). A different probability cut-off was determined for each model.

2.6. Model validation

For each vegetation layer, we extrapolated resulting models (hereafter referred to as "local vegetation" and "regional vegetation" models) to the rest of the study area and, where possible, to the ecological subregions (Miles and Goudey, 1997) covering the forested portions of surrounding counties, hereafter referred to as the Marin, Sonoma, and Napa subregions (Fig. 1). We developed 30 m by 30 m model prediction surfaces using ArcGIS 8.1 (ESRI, 2001).

To evaluate our models within the Marin subregion, we used owl nest locations that were identified and monitored using the same protocols as the nest locations used to build our models. To evaluate our models within the Sonoma and Napa subregions, we used a California Department of Fish and Game database of Northern Spotted Owl occurrence records, many of which are not nest locations, but represent approximate activity centers for known pairs.

For the local vegetation models, we were limited to the area covered by the local vegetation layer. Thus, we used a small set of nests from the Marin owl database that were located within this area (Fig. 1). For each owl pair that used more than one nest site, we randomly selected one site for our validation ($N = 10$). For comparison purposes, these nests were also used to evaluate the regional vegetation models. In addition, we were able to use data from a vegetation layer similar to the local layer, but produced for Napa County, to develop predictions for the Napa subregion; the Napa layer was produced with the same mapping protocols as were used in Marin County (Thorne et al., 2004). To evaluate these model pre-

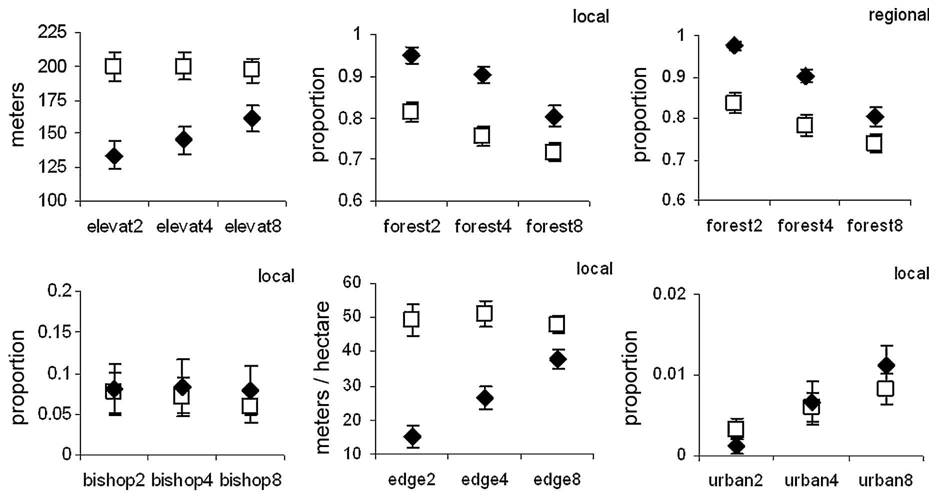

Fig. 2. Means and standard errors of landscape variables retained in final models at one or more scales (200-, 400-, or 800-m radius distances). Filled diamond = nest; open square = random. See Table 1 for variable definitions. Local = derived from local vegetation layer; regional = derived from regional vegetation layer.

dictions, we used records from the California owl database that overlapped this area (N = 31).

To evaluate the regional vegetation models, we used all records from the Marin owl database that fell outside the original study area within the Marin ecoregion (N = 24), and all records from the California owl database that fell within the Sonoma (N = 74) and Napa (N = 45) ecoregions. We evaluated the models separately for each of the three subregions in order to assess relative predictive ability.

Logistic regression model predictions consisted of a probability of owl occurrence for each forested pixel within the prediction area (subregion). For comparison of these predicted probabilities with actual owl nest sites, we chose the cut-off probabilities that maximized correct classification (model sensitivity plus specificity) for the original nest locations (Hosmer and Lemeshow, 2001). We then classified our validation points (N actual nest sites) as occupied (X) or unoccupied ($N-X$) based on those cut-off values. The proportion of actual nests classified by the model as occupied (X/N) was compared to the overall proportion of the forested area within a subregion that the model predicted as occupied (P). For each model, we calculated the exact binomial probability of observing X or more occupied sites, given that $Y = P \times N$ were expected. We considered this equivalent to testing whether or not owls used sites with high model values in higher proportions than their regional availability, and thus, whether our models provided more information about potential habitat suitability than did the distribution of forest habitat alone. However, where the model predicted fewer nest sites to be occupied than expected ($X < Y$), we calculated the exact binomial probability of observing X or fewer occupied sites.

3. Results

3.1. Nest-site habitat associations

Of the point- and landscape-level variables examined, the 200-m and 400-m radius variables generally resulted in higher differences than the 800-m radius variables (Fig. 2). Thus, for the local vegetation layer, all but one of the landscape variables (bishop pine) considered for the logistic regression models were based on 200-m or 400-m radius areas around the nest/random sites. For the regional vegetation layer, all but three landscape variables (bishop pine, California bay laurel, and shrub) were based on either 200-m or 400-m radius circles.

Resulting models indicated that owl nest sites were more likely to occur at south-facing sites that were lower in the watershed, as well as lower in mean elevation within 400 m, and with a higher proportion of woodland within 400 m (Table 2). Local vegetation models also indicated that nest sites were more likely to occur at sites with a lower proportion of bishop pine within 800 m, a lower proportion of urban development within 200 m, and less woodland edge within 200 m. Regional vegetation models did not reveal any associations with landscape-level cover of specific tree species or stand maturity/size.

3.2. Model validation

Within the original study area, local vegetation models performed better than regional vegetation models, with respect to AIC, ROC AUC, and proportion of original nest sites correctly classified (Table 3). Of the 18,960 ha of forest contained within this area, 4132 ha were predicted to provide suitable nesting habitat based on the local vegetation models (Fig. 3), while 4942 ha were predicted to be suitable based on the regional vegetation models (Fig. 4). Using independent nest locations as validation points, only the local vegetation model predicted significantly more suitable nest sites than expected by chance (Table 4).

Using the regional vegetation models, suitable nesting habitat across all three subregions was predicted to be 40,049 ha (Fig. 4). Overall, and within the Marin and Sonoma subregions, the model

Table 2
Logistic regression model coefficients and standard errors for nest-site occupancy models based on local and regional vegetation data (N = 132). See Table 1 for variable definitions. See Table 3 for model statistics.

Model	Variable	Coefficient	Standard error
Local vegetation	Elevat2	−0.0182	0.00486
	Shedpos	−4.69	1.75
	Aspectsouth	0.0138	0.00543
	Forest4	3.59	2.70
	Bishop8	−2.25	1.56
	Urban2	−46.5	35.1
	Edgelength2	−0.0388	0.0151
	Constant	1.28	2.62
Regional vegetation	Elevat2	−0.0111	0.00361
	Shedpos	−3.44	1.36
	Aspectsouth	0.00773	0.00447
	Forest4	7.40	1.95
	Constant	−4.65	1.68

Table 3
Logistic regression model diagnostics for nest-site occupancy models based on local and regional vegetation data ($N = 132$). The probability cut-offs were based on the values at which model sensitivity + specificity was maximized, and represent the predicted probability above which nest sites were classified as occupied (used to determine the proportion correctly classified).

Model	d.f.	Pseudo R^2	AIC	ROC AUC	Probability cut-off	Proportion correctly classified
Null	1	–	170.0	–	–	–
Local vegetation	8	0.463	98.23	0.916	0.434	0.856
Regional vegetation	5	0.317	124.8	0.865	0.355	0.796

classified the validation points with significantly greater success than would be expected by chance alone (Table 4). Within the Napa subregion, however, the model performed worse than expected by chance alone. The local vegetation model also performed worse than random within the portion of the Napa subregion for which a detailed vegetation layer was available (Table 4).

4. Discussion

4.1. Habitat associations

Other than the proportion of surrounding forest cover, topographic conditions were the strongest predictors of owl nest-site occurrence, with occupied sites lower in the watershed and more southfacing than unoccupied sites. The importance of slope position may be explained by a variety of factors, including susceptibility to heat stress, predator avoidance, prey abundance and availability, and nest structure availability (Barrows, 1981; Carey et al., 1992; Hershey et al., 1998; Folliard et al., 2000). Lower areas are, by definition, closer to surface water and therefore have lower average temperatures than adjacent uplands, possibly providing better growing conditions and larger trees for nesting. South-facing slopes may also contain larger individual trees, and tend to be more sheltered from spring and summer northwesterly winds.

In contrast with other studies, we found that, at the landscape scale, Marin owls were no more likely to be found in conifer-dominated areas than hardwood-dominated areas, and there did not seem to be a major influence of specific tree species composition on owl nest-site occurrence. Although the local vegetation model identified a negative association with the proportion of bishop pine forest within an 800-m radius, this effect may be related to the 1995 Vision fire, in which bishop pine forest was the primary vegetation type burned (Fellers et al., 2004). These results may indicate the generalist characteristics of this subspecies in this part of its range, where it utilizes a variety of forest types and nest tree characteristics. It may also be attributable to the high interspersion of conifer and hardwood types within our study area, which may

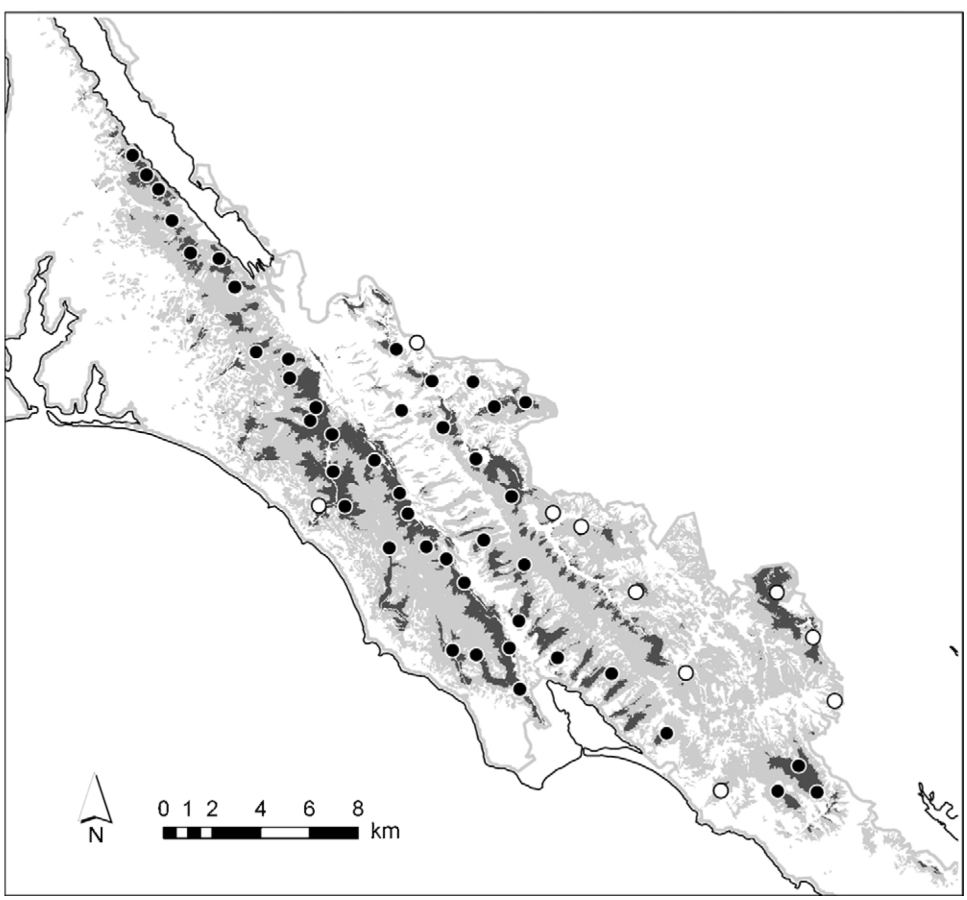

Fig. 3. Predicted probability of Spotted Owl occurrence for the area covered by the local vegetation layer (see Table 2 for model parameters). Dark gray shading represents areas of predicted occurrence based on probability cut-off values that maximized sensitivity vs. specificity in the original datasets (0.43). Light gray shading depicts current forest cover. Black circles are nest sites used for model-building; white circles are validation nest sites.

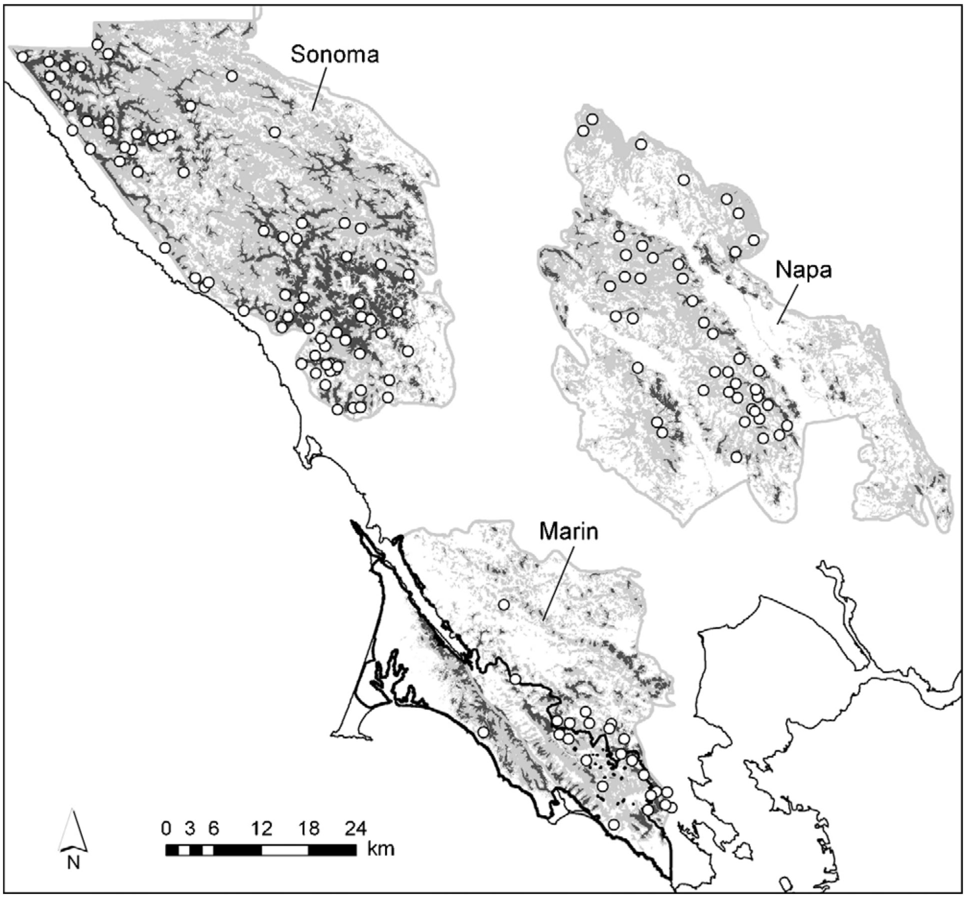

Fig. 4. Predicted probability of Spotted Owl occurrence for the Marin, Napa, and Sonoma subregions based on the regional vegetation layer (see Table 2 for model parameters). Dark gray shading represents areas of predicted occurrence based on probability cut-off values that maximized sensitivity vs. specificity in the original datasets (0.36). Light gray shading depicts current forest cover. White circles are validation nest sites. Black outline indicates the area covered by the local vegetation layer and depicted in Fig. 3.

represent an optimal mix of habitats with respect to prey density and accessibility (Ward et al., 1998). Thus, a conifer versus hardwood classification may be arbitrary in some cases, and may not adequately describe the actual habitat mosaic.

We detected no response to mean stand size, which contrasts with results from many other Northern Spotted Owl studies (Forsman and Griese, 1997; Hershey et al., 1998; Folliard et al., 2000) and may be due to the relatively young age of Marin forests,

Table 4
Classification of validation nest sites in Marin, Napa, and Sonoma subregions, according to local and regional vegetation models (Table 2). For each model, the numbers in the "expected random" column were determined by the overall proportions of the forested area that were predicted to be occupied/unoccupied[a]; the "actual nests" column represents the numbers of actual nests classified by the model as occupied/unoccupied. *P* values represent exact binomial probabilities[b].

	Regional vegetation Subregion (n)	Expected random	Actual nests	Local vegetation Subregion (n)	Expected random	Actual nests
Occupied	Marin (10)	2.97	5.0	Marin (10)	2.18	5.0
Unoccupied		7.03	5.0		7.82	5.0
P			0.146			0.046
Occupied	Marin (24)	4.43	11.0	–	–	–
Unoccupied		19.58	13.0	–	–	–
P			0.0019	–	–	–
Occupied	Napa (45)	3.6	1.0	Napa (31)	2.0	1.0
Unoccupied		41.4	44.0		29.0	30.0
P			0.115			0.388
Occupied	Sonoma (74)	18.9	32.0	–	–	–
Unoccupied		55.1	42.0	–	–	–
P			0.0007	–	–	–
Occupied	Overall (143)	27.2	44.0	–	–	–
Unoccupied		115.8	99.0	–	–	–
P			0.0005	–	–	–

[a] Areas predicted to be occupied were based on cut-off values corresponding to the model probabilities that maximized sensitivity vs. specificity in the original dataset (0.43 for local vegetation model; 0.36 for regional vegetation model).

[b] For the Marin and Sonoma subregions, *P* values represent the exact binomial probabilities of observing at least the number of occupied actual nests, given the proportion of the area that the model predicted as occupied. For the Napa subregion, *P* values represent the exact binomial probability of observing fewer than the occupied actual nests.

as well as the predominance of hardwood tree species. Mature tanbark oak, California bay laurel and coast live oak trees do not attain the same size as Douglas-fir and redwood trees, making it difficult to infer age differences in mixed conifer/hardwood habitat based on size. Apparently, all available stand size classes within the relatively narrow range of available sizes are important to the Marin Northern Spotted Owl population, making it more similar to the Mexican (*S. o. lucida*) and California (*S. o. occidentalis*) subspecies, which also use a wide variety of habitat types and ages (Seamans and Gutiérrez, 1995; Moen and Gutiérrez, 1997; Peery et al., 1999; Folliard et al., 2000).

However, Marin owls did appear to be negatively affected by habitat fragmentation (measured as the amount of woodland edge within 200–800 m) and anthropogenic impact (as represented by the proportion of urban development within the surrounding 200–800 m). The negative edge effect appeared to be due primarily to urban and grassland edges, with the latter consisting primarily of grazed, non-native annual grasslands. For the most part, urban edges within the study area were not hard edges, but represented wooded residential lots. Thus, we suspect that the fragmentation effect may be due to anthropogenic disturbance, rather than habitat non-suitability. However, Great Horned Owls (*Bubo virginianus*) are also known to forage along urban and grassland edges (Bennett and Bloom, 2005), and as an owl predator and competitor (Forsman et al., 1984), they may play a role in edge avoidance.

4.2. Scale of response

Marin owls appeared to respond more strongly to landscape conditions within a 200-m or 400-m radius, compared to an 800-m radius. This corresponds with other studies that found the larger the radius examined, the smaller the differences (Hunter et al., 1995; Meyer et al., 1998; Swindle et al., 1999; Thome et al., 1999), although the ranges of radii examined were larger than ours. Given the relatively high density of this population, as well as high landscape heterogeneity at small spatial scales, we would expect more immediate local conditions to have greater influence on nest-site occurrence. However, the overlap between nest and random point characteristics at the 800-m radius distance may also contribute to the relatively weak relationships at this scale.

4.3. Model performance

Within the study area, the local vegetation layer produced a better model than the coarser regional vegetation layer, in terms of explanatory power, model fit, and classification success (original and independent datasets). Comparing the two models, variables had similar effects, but fewer variables were present in the regional vegetation model, suggesting that this data layer was too coarse to represent habitat edges and discriminate between meaningful vegetation types at a spatial scale relevant for owls. Thus, the higher spatial accuracy and more detailed vegetation classification system of the local layer may better reflect habitat conditions for the owl at a scale meaningful for management. Several researchers have demonstrated the importance of spatial resolution (Li et al., 2006) and botanical detail of vegetation/cover layers (Lawler et al., 2004; Manton et al., 2005), as well as the scale of landscape metrics (Parody and Milne, 2004; Johnson et al., 2005) in the development and interpretation of habitat suitability models.

Nonetheless, some information is always lost in creating a vegetation classification from an aerial image. All vegetation layers rely on human-defined vegetation classifications that may not represent the conditions to which owls respond. Thus, modeling with unclassified raw imagery (spectral signatures, rather than a priori vegetation classes), especially hyperspectral (Ustin and Trabucco, 2000; Tuttle et al., 2006) or high-resolution imagery (Pasher et al., 2007), may be more useful than detailed, accurate vegetation classification for improving model predictive power (Suarez-Seoane et al., 2002). Additional factors not readily captured in remotely sensed imagery or classified vegetation layers, such as nest tree characteristics and prey availability, may also explain additional variability in site suitability.

4.4. Extrapolation to new areas

Although the local vegetation layer resulted in a better model for our study area, it appears that the regional vegetation layer was adequate for prediction purposes within the neighboring Marin and Sonoma subregions. Indeed, distributions of many bird species, especially large-bodied and/or wide-ranging species, have been shown to be well predicted by general land cover data (Seoane et al., 2004) and landscape pattern (Loyn et al., 2001).

While model extrapolation to adjacent subregions generally under-predicted owl sites, this may be due in part to the low spatial resolution of the validation dataset, which represents owl activity centers, and not necessarily specific nest sites. Given the low inter-annual variation in within-pair nest-site locations, however, we would expect these activity centers to be reasonable substitutes for actual nest locations.

The model performed much better in the coastal Sonoma subregion, which is more similar — in elevation, climate and vegetation — to Marin than the inland Napa subregion. This suggests that our model results should only be applied under similar habitat conditions, and that each subregion may require a separate model, preferably with vegetation layers similar to the local layer used here. By extension, our results are certainly not applicable in the Pacific Northwest, or even northern California, where topography, forest types and prey species differ (Forsman et al., 1984). In general, our results support the notion that regional stratification is a prudent approach to modeling species' habitat associations (Cardillo et al., 1999). Geographically weighted regression is another option that allows simultaneous fitting of geographically specific habitat relationships (Osborne et al., 2007).

Although it was not possible to develop a narrow definition of owl nesting areas in this region based on traditional criteria such as forest type or size class, we found that landscape-level characteristics such as forest connectivity and topographic conditions were important predictors of owl occurrence, and that spatial predictions based on locally derived models were useful for understanding the patterns of habitat use. Within our study area, the models fit the data reasonably well and could be used to predict nest-site locations with high certainty. In other similar coastal areas, our models had less certainty, but were well suited to provide a coarse-filter identification of potential habitat, which may then be surveyed on the ground for precise owl locations. Our model predictions have been used by local planning agencies to identify areas where owl surveys should be conducted prior to proposed developments and other projects.

5. Conclusions

The Marin Northern Spotted Owl population is somewhat anomalous, in terms of its high density and generalist vegetation associations. It is possible that the heterogeneous forest conditions along with the dense prey base (Willy, 1992) provide owls with optimal habitat conditions, explaining the localized high density and broad range of habitat types used for nesting. The definition and mapping of locally relevant habitat associations has allowed land managers, local governments, and wildlife biologists to better understand and protect owls and their habitat in Marin. In light of the negative associations that we found between habitat fragmentation, urban development, and nest-site occurrence, it will be important to maintain the continuity of forested habitats and to assess the cumulative impact of development within the home ranges of owls in Marin.

Although logistic regression models can be a useful tool in predicting bird distributions and habitat occupancy, our results also demonstrate the value of using locally derived models to develop predictive maps. Our results also highlight the caution that should be exercised when predicting outside of the range of one's original dataset. However, depending on management goals, simple, hypothesis-driven spatial models may be used successfully as coarse filter detectors of potential owl habitat, saving time and resources for land managers.

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From: Dominick DellaSala <dominick@geosinstitute.org>
Sent: Friday, April 25, 2014 4:22 PM
To: Wildlife Management
Subject: submission of comments on NSO status review
Attachments: geosNSOstatelistingcomments.pdf

Attached are comments I would like to submit for the record regarding the state of California's status review of the Northern Spotted Owl. My comments provide extensive documentation of the status of the owl and need for listing under the California Endangered Species Act given the precarious status of the species rangewide and in California and the numerous listing factors documented herein.

Feel free to contact me should you have any questions on our submission.

Dominick A. DellaSala, Ph.D | President, Chief Scientist
Editor and Primary Author of Temperate and Boreal Rainforests of the World (www.islandpress.org/dellasala)

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"Those who have the privilege to know, have the duty to act." Albert Einstein

May 1, 2014

California Department of Fish and Wildlife
Nongame Wildlife Program
Attn: Neil Clipperton
1812 9th Street
Sacramento, California 95811
Submitted via: *wildlifemgt@wildlife.ca.gov*

Re: Comments Regarding CDFW Status Review for the Northern Spotted Owl (*Strix occidentalis caurina*)

Dear Mr. Clipperton:

As a member of the U.S. Fish & Wildlife Service recovery team for the Northern Spotted Owl (*Strix occidentialis caurina*) from 2006-2008, I am considered an expert on habitat needs and population status of this imperiled species. Thus, pursuant to the state's status review and potential listing of this species under the California Endangered Species Act (CESA), please consider these comments in your review. Specifically, the Northern Spotted Owl (NSO) warrants listing under the CESA because, like the federal listing, it also meets several listing criteria, including: 1) past, present, and threatened habitat destruction, modification or curtailment; 2) competition from invasive species; 3) inadequate regulatory mechanisms; and 4) climate change threats.

In study areas not managed under the Northwest Forest Plan, such as nonfederal lands in California, owl declines are about twice as great (Anthony et al. 2006) due primarily to higher rates of logging and inadequate regulatory mechanisms. Moerover, a recently published large-scale demographic study (Forsman et al. 2011) found that the species has been declining on seven of eleven active demographic study areas, including California, at about 3% annually range-wide from 1985-2008. Funk et al. (2010) provides evidence for recent genetic bottlenecks in NSO that increase the species' vulnerability to range-wide extinction.

Areas that have little federal land support few or no owls, and Forsman et al. (2011) state that as a result too few NSO exist in four regions (southwestern Washington, the Coast Range of northwest Oregon, the California Cascades, and much of Washington's Olympic Peninsula) to conduct a demographic study with their methods. Further, the literature suggests these declines are not likely to lessen even with the recent federal owl recovery plan in place due to the un-quantified and unmitigated risks from active management and post-fire logging and high rates of logging on nonfederal lands. Thus, review of recent demographic rates, competitive interactions with Barred Owls (*Strix varia*), inadequate state regulations, climate change threats, and other recent threats discussed herein, provide sufficient justification for a determination by the state of California that the species warrants state-listing and the protections afforded it under the CESA.

PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF THE OWL'S HABITAT OR RANGE

The NSO is threatened by historic and ongoing loss and adverse modification of habitat due especially to logging. Over a century of logging has removed much of the owls' habitat. In 1990, habitat loss was estimated at 60-88% since the early part of the 19th century (USFWS 1990a, b, also see Strittholt et al. 2006 for similar estimates). Since the owl was federally listed in 1990, habitat loss has continued range-wide, most notably on nonfederal lands (Stauss et al. 2002, Courtney et al. 2004, Anthony et al. 2006, USFWS 2008, 2009, 2010a) and is likely to continue from post-disturbance logging, thinning, and logging of old forests on nonfederal and federal (to a lesser degree) lands. Additionally, it appears that the effects of past logging still are occurring on both federal and nonfederal lands as increased fragmentation and habitat loss propagate through the range of the owl (see FEMAT 1993, Courtney et al. 2004 for further discussion of lag effects) combining synergistically with Barred Owl extirpations of NSO territories (Dugger et al. 2011, Wiens 2012).

Important components of functional old-forest habitat for NSO and their prey such as standing dead trees, large down wood, multi-layered canopies, and other features have been lost throughout much of the owls' range mainly due to logging. In many places, it will take centuries for forests to recover their former productivity even with the Northwest Forest Plan, recovery plan, critical habitat determination, and other measures on federal lands. In particular, the Northwest Forest Plan assumed a period of decades would be necessary before habitat in many of the late-successional reserves (LSRs) became suitable for owls; only about 36% of the reserves currently are functioning as old-growth forests >150 years with about 59% in late-seral condition (Strittholt et al. 2006). Thus, it cannot be assumed that the LSR network and critical habitat is sufficient to recover the owl, particularly under increased threats on nonfederal lands (see below). Additionally, other human actions, including post-disturbance logging and extensive fuel treatments, and urban development have contributed to past and continue to contribute to present cumulative losses and degradation of NSO habitat and their prey.

CURRENT AND HISTORIC DISTRIBUTION

Historically, NSO was found from British Columbia south through western Washington, western Oregon, and northwestern California from Siskiyou County south to Marin County (American

Ornithological Union 1957, Forsman et al. 1984, Gutiérrez et al. 1995). The ranges of the NSO and California Spotted Owl meet at the southern end of the Cascade Range in northern California (Thomas et al. 1990, USFWS 1992, Barrowclough et al. 1999, Haig et al. 2001).

The owls' range includes three states and generally is divided as: Washington (four physiographic provinces), Oregon (five provinces), and California (three provinces) (Thomas et al. 1993). Long-term monitoring sites have been established in all three states, with 3 in Washington, 5 in Oregon, and 3 in California. In California, populations are declining in two of three long-term monitoring sites (see Table 3 below). It is clear that NSO status and distribution have declined since the subspecies originally was listed in 1994, and that the NSO is at risk of extinction throughout a significant portion, it not all, of its range.

HABITAT REQUIREMENTS

Large areas of older, structurally complex forests provide the habitat necessary to support viable populations of NSO. Extensive studies have supported the strong association of NSO and older forests (Table 1), particularly to adult survival. NSO select older forests for nesting (Hershey et al. 1998, Swindle et al. 1999), roosting, and foraging (Forsman et al. 1984, Bart and Forsman 1992, Thomas et al. 1990, Herter et al. 2002, Glenn et al. 2004, Forsman et al. 2005). Nest occupancy is related to the presence of mature and old-growth forests although the nature of this relationship varies regionally (Carroll and Johnson 2008). On private lands in northwestern California, NSOs usually occur in the oldest forests available (Diller and Thome 1999).

Table 1. Studies documenting the association between NSO and older forest habitats.

Variable	Effect	Association	Reference
"demographic parameters on some study areas"	+	% cover suitable habitat	Forsman et al. 2011
recruitment	+	% habitat	Forsman et al. 2011
recruitment	+	federal lands (contained highest proportion of habitat)	Forsman et al. 2011
nesting	+	older forests	Hershey et al. 1998, Swindle et al. 1999
roosting and foraging	+	older forests	Forsman et al. 1984, Bart and Forsman 1992, Thomas et al. 1990, Herter et al. 2002, Glenn et al. 2004, Forsman et al. 2005
occurrence	+	oldest forests available on managed forests on private lands in northwestern California	Diller and Thome (1999) Thome (1997)

nesting, roosting, and foraging	+	strong associations with older forests	LaHaye and Gutiérrez 1999
understory structure important for spotted owls and their prey	+	older forests	Carey et al. 1992, Rosenberg and Anthony 1992 Buchanan et al. 1995, LaHaye and Gutiérrez 1999, Lehmkuhl et al. 2006
apparent survival	+	amount of old forest habitat surrounding nesting territories	Franklin et al. 2000, Dugger et al. 2005, Olson et al. 2004
fecundity	+	amount of old forest habitat surrounding nesting territories-northern California	Franklin et al. 2000, southern Oregon - Dugger et al. 2005, Olson et al. 2004
reproductive rate	+	proportion of old-growth forest within a 730-m-radius circle around annual activity centers - in southern Oregon	Dugger et al. 2005
colonization rate	+	territories with more mature conifer forest - California Spotted Owls, Sierra Nevada of California	Seamans and Gutiérrez (2007)
extinction rate	-	territories with more mature conifer forest - California Spotted Owls, Sierra Nevada of California	Seamans and Gutiérrez (2007)
occupancy	-	additive and negative effect of barred owls and decreased amounts of habitat – nesting territory scale	Dugger et al. 2011, Carroll and Johnson 2008
colonization	-	additive and negative effect of barred owls and decreased amounts of habitat – nesting territory scale	Dugger et al. 2011
extinction	+	additive and negative effect of barred owls and decreased	Dugger et al. 2011

	amounts of habitat – nesting territory scale	

Recruitment is positively related to the proportion of older forest habitat in owl territories and higher levels of recruitment have been witnessed on federal lands with high proportions of old forest habitat (Forsman et al. 2011). Other studies have documented lower reproduction in areas with less suitable habitat. For example pairs produced fewer fledglings in areas with < 20% habitat (average = 0.33 fledglings/pair) than in areas with > 60% habitat (average = 0.93 fledglings/pair) (Bart and Forsman 1992). Understory structure is important for owl prey (Carey et al. 1992, Rosenberg and Anthony 1992, Buchanan et al. 1995, LaHaye and Gutiérrez 1999, Lehmkuhl et al. 2006). Survival and fecundity are positively associated with the proportion of old forest surrounding nesting territories (Franklin et al. 2000, Dugger et al. 2005, Olson et al. 2004). In southern Oregon reproduction increased as the proportion of old forest within 730 m of activity centers increased (Dugger et al. 2005). Habitat may partially mitigate the effects of the invasive Barred Owl as NSO had lower extirpation rates in territories with high levels of suitable habitat (Dugger et al. 2011, Wiens 2012).

PRESENT OR THREATENED DESTRUCTION, CURTAILMENT, OR ADVERSE MODIFICATION OF HABITAT OR RANGE

Impacts of historic habitat destruction were particularly severe at lower elevations, in the Coast Range of Oregon and California and in southwest Washington, where substantial owl habitat was high-graded by logging the biggest trees first (USFWS 1990b). The few federal lands present in these regions are the backbone for owl recovery because of heavy logging in surrounding non-federal lands provided they are managed with protection of owl nesting, roosting, and foraging habitat in mind.

According to conservative estimates provided by the U.S. Fish & Wildlife Service NSO habitat losses continue across ownerships, but are of particular concern on nonfederal lands (Table 2).

Table 2. NSO habitat losses across ownerships, 1994 to 2004.

Area (acres)	Time	Ownership	Cause	Description	Citation
16,900	1994 to 2003	Federal	Clearcutting	older forest	Moeur et al. 2005
141,300	1994 to 2004	Federal and non-Federal	Stand replacing fire[1]	owl habitat	Raphael 2006
155,999	1994 to	Federal	Management	owl habitat	Courtney et

[1] We note that the evidence for fire impacts to owls is currently being debated in the scientific literature (see Hanson et al. 2009 for a summary of the issues)

	2003		including partial harvest		al. 2004
583,500	1994 to 2004	Non-Federal	Clear cut	owl habitat	Courtney et al. 2004

In excess of 96% of California's old-growth redwood forests are gone (Noss 2000). Important components of functional old-forest habitat for owls and their prey such as standing dead trees, large down wood, multi-layered canopies, and other features have been lost throughout much of the owls' range and are in short supply particularly on nonfederal lands mainly because of lax forest practices. In many places, it will take centuries for forests to recover their former productivity even with the Northwest Forest Plan, and other measures in place due to the extensive ecological debt in late-seral habitat (see Strittholt et al. 2006).

In addition to the above losses, competitive pressure from Barred Owls appears to be limiting NSO use of the LSRs (see Pearson and Livezey 2003, 2007). Thus, many of the LSRs may lose their functionality as a result of exclusion by Barred Owls requiring stepped up habitat conservation. These losses combined with ongoing post-disturbance logging, forest thinning for fuels reduction that may be more harmful to owls than forest fires (see Hanson et al. 2009, 2010, Odion et al. in press – Appendix A), and logging on nonfederal lands all demonstrate increasing risk factors. In sum, there is ample evidence for state listing of the owl as the combination of range contraction, population declines (throughout most of the range – Anthony et al. 2006, Forsman et al. 2011), ongoing habitat losses (range-wide), increasing threats from multiple interacting factors, and inadequate regulations, particularly on nonfederal lands, likely will result in the owls' eventual extinction absent stepped up habitat protections and improved regulations.

DISEASE OR PREDATION

The NSO is subject to disease and predation pressures that have increased substantially since listing. West Nile Virus has killed wild birds since its introduction in 1999 and subsequent spread across North America (McLean et al. 2001, Caffrey 2003, Marra et al. 2004, Blakesley et al. 2004), and owls are known to be susceptible (Fitzgerald et al. 2003, Gancz et al. 2004). In addition, recent examination of the rates of infection by blood parasites indicates that the NSO has a high rate of infection by blood parasites (Ishak et al. 2008). Changes in habitat that result in more open areas (e.g., from forest thinning) and increased fragmentation of older forests likely cause an increase in predation by Great Horned Owls (*Bubo virginianus*), Northern Goshawks (*Accipiter gentilis*), and Red-tailed Hawks (*Buteo jamaicensis*) that either increase mortality on adult spotted owls or dispersing juveniles. In addition, Leskiw and Gutiérrez (1998) present evidence of predation on NSO by Barred Owls, a risk that is growing with increasing overlap in distribution of these co-generic owls.

INADEQUACY OF REGULATORY MECHANISMS

The status of NSO and its old-forest habitat is subject to adverse modification due to the inadequacy of existing regulations. Existing regulations have failed to protect habitat on nonfederal lands. This failure is evidenced by the continued loss and degradation of habitat range-wide, particularly on nonfederal lands (e.g., Stauss et al. 2002, Courtney et al. 2004, Anthony et al. 2006, USFWS 2008, 2010a), the failure of habitat degraded by past management practices to be fully restored (e.g., Courtney et al. 2004), and by a demonstrated failure to reverse the decline of the NSO over the last two decades (e.g., Forsman et al. 2011). Inadequacies generally fall into the following categories: variable level of protection given to owls and habitat depending on the presence or absence of special designation (e.g., activity center, nest site); lack of landscape-scale planning on nonfederal lands; use of survey protocols and other standards that fail to incorporate current relevant science; prevalence of discretionary guidelines and/or unclear or unsuitable direction; failure to consistently require involvement of personnel with biological expertise in evaluating/assessing ecological information (discussed below).

One review by USFWS examined 75 verified NSO territories on private timberlands in two counties in California; 77% had declined to either "no response" or a "territorial single owl." Of the sites on Forest Service-administered lands, only 20% of the pair sites changed status during the same time period (USFWS 2010). Such a strong difference between relative success on federal and private lands "supports the contention that management on private timberlands is creating habitat conditions that do not support sustained occupancy by northern spotted owl" (USFWS 2010).

In California, since the 1992 adoption of the Forest Practice Rule provisions related to the NSO, further research has been conducted that has caused concern over the adequacy and continued relevance of the Rules. USFWS has expressly indicated that the use of measures contained in 14 CCR § 919.9(g) may not always ensure NSO take avoidance. According to several emails, USFWS staff believes that the application of the Rule "*typically does not* avoid or reduce the likelihood of take of northern spotted owl" because the habitat definitions and retention standards in the Rules "represent minimum values that are *below* the habitat parameters associated with reasonable levels of territory occupancy survival, and reproduction by northern spotted owl" (see: Jan 24, 2008 email from USFWS's Brian Woodbridge to CAL FIRE's Chris Browder; April 3, 2009 Email from USFWS' Ken Hoffman to CAL FIRE's Chris Browder; and April 22, 2009 Email from USFWS' Brian Woodbridge to CAL FIRE's Chris Browder).

The USFWS has stated that the use of California Wildlife Habitat Relationships [WHR] habitat definitions in the Rules is "unlikely to avoid take" (according to the emails identified above). This is because the WHR types are considered to be NSO habitat (i.e., 4M & 4D) are widely variable, and, at the lower end of size class/density, typically are poor habitat or non-habitat.

Harvest within 4D and 4M stands typically further reduces habitat quality significantly, sometimes to the point where take is likely, even when the post-harvest structure still meets 4M or 4D criteria." In fact, the standards for habitat typing and retention developed in 1992 are known to be inadequate to prevent owl take. CAL FIRE has accepted USFWS' arguments openly, and as a result has requested that timber harvest plan submitters provide substantial evidence in the plan record that NSO take has been avoided, and recommends that the plan proponent use habitat descriptions contained in the USFWS Habitat Descriptions 2 when addressing NSO take avoidance using guidelines and §919.9(e) and (g) (PRC §21081(a), 14 CCR §§15065(a)(1), 15091(a)(1) and (b); CAL FIRE's Use of 14 CCR §919.9(g) [939.9(g)] in Making Northern Spotted Owl Take Avoidance Determinations; CAL FIRE (2008)).

One blatant failure of the Rules is its inability to incorporate the relevant science that has been developed since the original provisions related to NSO were adopted in 1992. The USFWS provided guidelines for habitat typing and protection in 2008 that provide substantially more protection for high-quality owl habitat than do California's Rules. While CAL FIRE may prefer that logging proponents follow the USFWS Guidelines, the agency clearly lacks authority to require protections in excess of those provided in its Rules. In addition, many studies have been published on the topic since February 2008 and should be considered and incorporated into updated take evaluation guidelines. Unfortunately, in their essential provisions with respect to owl habitat typing, California's Rules have not changed since 1992. Today, they fall far short of the best available science as embodied in the USFWS's 2008 Guidelines.

The Rules do not consider the concept of habitat fitness potential (HFP), wherein evaluation of habitat parameters influencing survival and reproduction rates provides a more rigorous measure of "significant impairment of essential behavioral patterns such as breeding, feeding, or sheltering" that is readily incorporated into review of timber harvest plans. The evaluation of predicted effects of habitat modification on northern spotted owl affected by a project would be more robust by the incorporation of HFP. Section 919.9(g)(3) ignores the well-documented fact that NSO territories require a combination of habitat types to provide habitat for breeding, feeding, and sheltering, be functional, and retain occupancy (Hoffman, April 3, 2009 email, citing Zabel et al. 2001, 2003). USFWS staff asserted in the April 3, 2009 email that, as written, §919.9(g)(3) allows harvest of virtually the entire core area down to unsuitable conditions. Section 919.9(g)(4) includes the same definitions that allow poor quality habitat. Along with the Rules' general lack of grounding in the best Barred Owls may be present, as current survey protocols readily yield false negative results due to changes in NSO behavior when Barred Owls are present. The new rules continue to incorporate the 1992 survey protocol, which does not reflect the best available science. This is particularly relevant given the new rules adoption of "unoccupied" status in §895.1(a)(4).

More recent data, including modeling efforts, have raised concerns about the efficacy and accuracy of the 1992 protocol. Of particular concern is how well the 1992 protocol works in areas experiencing the recent invasion of the Barred Owl, which has had a suppression effect on NSO response rates, and may be affecting occupancy dynamics of spotted owls in the landscape (Olson et al. 2005, Crozier et al. 2006). According to one report, "estimates of annual colonization rates and the summary of empirical data, indicated that three years of surveys were not sufficient to conclude that a site historically occupied by NSO, but then unoccupied (or at least a spotted owl is not detected), will never be occupied in the future" (Dugger et al. 2009). Dugger et al. (2009) further goes on to state that for historically occupied sites, it's probably not ever appropriate to consider a site incapable of being occupied if there have been no habitat changes. Conversely, allowance of habitat modifications likely will cause the site to become permanently 'extinct.' In closing, Dugger et al. (2009) state that the current protocol is a prescription for continued habitat loss and declines of spotted owl breeding populations.

Direction Is Unsuitable, Unclear, or Discretionary

In California, habitat definitions in §895.1 describe habitats that typically are considered unsuitable, or at best represent the bare minimum conditions. For example, discussions in the USFWS emails identified previously point out that while functional "nesting habitat" is defined essentially as 4M/D or greater, virtually all NSO research describes nesting habitat as consisting of stands of much larger trees, with nest sites associated with very dense clumps.

The definition of an "active nest site or pair activity center" in §919.9(g)(1) is vague, and exclusionary. It fails to include all the sites entitled to protection under the Endangered Species Act. In addition, definitions for "timber operations" (refers to all activities that are involved in a logging operation, up to and including the removal of trees) and "Nesting habitat" are inappropriately or ill defined. It is virtually impossible to say exactly what characteristics of the habitat within 500 feet of an activity center the owls are keyed in on when selecting the nest site. This further renders it impossible for a registered professional forester (RPF), CDFG, the Director of California Department of Forestry (CAL FIRE), or USFWS to determine what measures are appropriate to adopt to protect nesting habitat, other than to prohibit tree removal. Inappropriate standards may allow adverse modification, even within critical nesting core areas that are likely to result in take. "Habitat" definitions allow for practices that result in poor quality habitat; the rules allow harvest of virtually entire core areas down to unsuitable conditions.

Finally, CAL FIRE lacks both the biological expertise and the regulatory authority to adequately evaluate take avoidance. Given that the 2008 USFWS Guidelines were written to provide a functional mechanism for translating the best available scientific information into effective habitat protections when employed by non-experts in owl habitats and biology, it is far from clear that CAL FIRE can reliably determine when a departure from the Guidelines will not result in an owl take. It is clear that CAL FIRE may not require THP proponents to follow the

Guidelines, which do not have the force of a regulation absent promulgation by the Board of Forestry.

Involvement of Qualified Personnel Is Inconsistent
Ensuring the participation of qualified, independent, biological experts is critical to reducing the risk of inadvertent harm. Unfortunately, state regulatory mechanisms in California do not provide such assurances, and both state and federal wildlife agencies have ceased to review timber harvest plans for owl impacts. Rule changes adopted in 2009 and 2010 minimize impartial scientific input, vesting responsibility key functions in evaluating and conserving owl habitat in private parties likely to have a financial interest in minimizing protections for owls and their habitat.

The prior rules required a "state-employed" biologist to participate in take avoidance determinations and mitigation of habitat impacts. A "Spotted Owl Expert" [SOE] is given such responsibility in the new rules. CAL FIRE designates SOE's, who need demonstrate only a limited level of expertise, and who usually are persons employed by timber companies. The new rules also removed requirements for CDFG review previously found in §919.9(g)(1), (3) and (4). Section 919.9(g)(2) allows a non-biologist, the Registered Professional Forester [RPF], to determine what is sufficient in terms of functional characteristics to be provided post-harvest, without requiring approval from CDFG or the Director of CAL FIRE. The rule further does not take into consideration 1,000-foot circles that may be shared by adjoining landowners. The review process does not incorporate information among landowners, so it is possible to have two unqualified RPFs making independent determinations regarding what is sufficient to retain within a single roost zone. Furthermore, without a requirement that the 1,000-foot circle contain even a minimum amount of habitat described in the rules as roosting prior to proposing operations within the circle, this rule easily could result in the only actual roosting habitat contiguous with the nest tree being reduced to some RPFs idea of minimum functionality without benefit of review by an independent state-employed biologist, DFG, or even the Director of CAL FIRE. USFWS staff emails indicate that it is highly possible that the removal of habitat necessary to provide sheltering would occur.

In addition, during the past four years, the USFWS has ceased to offer informal consultation on California THPs, and the California Department of Fish and Game has ceased to review THPs, including field reviews, expect for anadromous fisheries impacts. Thus, neither the state nor federal wildlife agencies are engaging in expert evaluation of proposed logging plans in the way that has proven critical, if inadequate, in the past. There is no evidence to suggest that it is reasonable to expect such a half-dismantled system of self-administered guidelines to effectively prevent the continued loss of owl habitat and owl take.

Landscape-level Planning Is Lacking

There is a significant lack of comprehensive planning for NSO on nonfederal lands, especially at a landscape-scale. However, these owls are associated strongly with particular landscape features, such as lower slopes and stream courses. Further, they are sensitive to landscape-scale spatial relationships between nesting, foraging, and roosting habitats. A failure to understand current scientific findings regarding these relationships *and* incorporate these understandings into landscape-scale planning mechanisms is a significant failure of state regulatory schemes.

Notably, discretionary guidelines in California focus solely on individual NSO territories. They fail to incorporate issues such as connectivity and dispersal habitat, wintering habitat, or longer-term habitat disturbance patterns. The state's rules fail to address habitat quality and quantity at scales relevant to territorial occupancy and fitness. The rules do not require any consideration of the spatial distribution of retained habitat. As a result, the rules enable harvest operations to occur in preferred areas where effects to NSO are relatively greater. Finally, the timber harvest plan review process is conducted on an individual case-by-case basis. This approach preempts a systematic region- or ownership-wide assessment of habitat conditions and owl status, and therefore makes the owl and its habitat particularly vulnerable to a magnification of effects arising from multiple separate harvest plans. In fact, the USFWS (undated) has noted problems with the cumulative effects of repeated entries within many NSO home ranges that have reduced habitat quality to such a degree that it causes reduced occupancy rates and frequent site abandonment.

The USFWS has asserted that under California's rules, there is strong evidence that habitat modification within critical nesting core areas is likely to result in a take. US Fish and Wildlife Service emails attribute this partially to the fact that the Forest Practice Rules allow low habitat quality, but also recognize that the actual habitat features selected by a given pair of NSO are unknown (although likely associated with features such as dense clumps, deformed trees, shading, aspect, water, and others that in combination result in a suitable nest site). Timber harvest typically disrupts, modifies, and removes these elements. These same USFWS emails assert that studies of NSO territory occupancy and fitness relative to habitat quality and quantity strongly indicate that in the Interior zone, NSO rely on functional (= high quality) habitat ***at much larger scales*** than described in the rules [emphasis added]. The small patches of habitat within 500 to 1000' buffers (even if maintained well above the minimum "suitable habitat" definition) are much less than the 200 to 300-acre core areas associated with continued occupancy and reproduction by NSO. Further, NSO nesting core areas often consist of multiple nest sites within a cluster of stands, not just one. All of these factors can be dealt with only as part of a landscape-scale planning effort.

CURRENT RELEVANT SCIENCE IS IGNORED IN TIMBER HARVEST PLANS

The NSO is threatened by continued increase in Barred Owl populations. In addition, ongoing human-caused climate change will magnify the threats the NSO already faces as fecundity levels have been shown to be determined, in part, by weather extremes (Anthony et al. 2006, Forsman et al. 2011). These detrimental impacts may be interacting with habitat loss and fragmentation to accelerate the decline of NSO populations (Anthony et al. 2006, Dugger et al. 2011, Wiens 2012), particularly on nonfederal lands as noted. Barred Owls compete with NSOs and are considered a major threat. Collapse of NSO populations has followed the north to south invasion of the Barred Owl and areas that recently have been invaded by this owl, such as in northern California, are beginning to show signs of population declines. Additionally, climate change is an emerging threat. Projected climatic changes in the Pacific Northwest likely to negatively affect spotted owls include increases in spring precipitation (a condition associated with decreased NSO reproductive success), increases in weather extremes, and changes that will affect prey availability and abundance. Projected changes in precipitation and temperature also likely will increase stress on NSO habitat, magnify the detrimental impacts of past and ongoing habitat modifications, and may impair habitat recovery rates.

Table 3. Changes in NSO demographic parameters up to 24 years (USFWS 2010).

Study Area	Fecundity	Apparent Survival[1]	Population Change[2]
Cle Elum (WA)	Declining	Declining	Declining
Ranier (WA)	Increasing	Declining	Declining
Olympic (WA)	Stable	Declining	Declining
Coast Range (OR)	Increasing	Declining since 1998	Declining
HJ Andrews (OR)	Increasing	Declining since 1997	Declining
Tyee (OR)	Stable	Declining since 2000	Stationary
Klamath (OR)	Declining	Stable	Stationary
Southern Cascades (OR)	Declining	Declining since 2000	Stationary
NW California (CA)	Declining	Declining	Declining
Hoopa (CA)	Stable	Declining since 2004	Stationary
Green Diamond (CA)	Declining	Declining	Declining

[1]Apparent survival calculations are based on model average.
[2] Population trends are based on estimates of realized population change.

Forsman et al. (2011) clearly demonstrate that NSO is on a downward trajectory with an estimated 2.9% decline per year from 1985 to 2006. The authors concluded that fecundity, apparent survival, and/or populations were declining on most study areas, and that there was evidence that increasing numbers of Barred Owls and loss of habitat were at least partly the cause for these declines. Concerns about habitat loss are attributable to extensive historic destruction and degradation of habitat, ongoing habitat loss, increasing risks from extensive thinning in owl habitat (Odion et al. in press, Appendix A), threats posed by climate change, and the lack of significant provisions to protect owl habitat on nonfederal lands.

Areas that have little federal land support few or no owls and Forsman et al. (2011) state that too few NSOs exist in these regions (i.e., southwestern Washington, the Coast Range of northwest Oregon, the California Cascades, and much of Washington's Olympic Peninsula) even to conduct a demographic study with their methods. It is likely that these declines will continue on both federal and especially on non-federal lands unless significant changes are made.

CLIMATE CHANGE

The USGCRP (2009) reported that in the Pacific Northwest, annual average temperature rose about 1.5°F over the past century, with some areas experiencing increases up to 4°F. Further, the region's average temperature is projected to rise another 3° to 10°F later this century, with higher emissions scenarios resulting in warming in the upper end of this range. USGCRP (2009) also reports that many climate models project further increases and decreases in winter and in summer precipitation, respectively, for the Northwest. They conclude that impacts related to changes and snowpack, streamflows, sea level, forest composition and other factors are already underway, with more severe impacts expected in the coming decades in response to continued warming. Researchers from the Pacific Northwest also report that current projections for future climatic conditions include year-round warming, wetter winters, and hotter, drier summers (Mote and Salathé 2009, Salathé 2006).

These changes in climate are an important direct threat to conservation and recovery of NSO. Researchers have documented the association of weather and climate patterns and NSO demography (Wagner et al. 1996, Franklin et al. 2000, Olson et al. 2004, Glenn 2009). The demographic study found that associations between fecundity, apparent survival, or recruitment, and weather covariates varied among study areas (Forsman et al. 2010). While past weather may not explain much of the decline in NSO populations over recent decades, weather conditions caused by a climate change may add to the existing problems faced by NSO. Glenn et al. (2010) found that projected climate changes: "…have the potential to negatively affect annual survival, recruitment, and consequently population growth rates for northern spotted owls."

On four of six areas studied, λ (or population growth rate) was positively associated with growing season that likely affects prey populations and negatively associated with cold, wet winters and nesting seasons and the number of hot summer days (Glenn et al. 2010). Interestingly, annual survival was more closely related to regional climate conditions, while recruitment was often associated with local weather. There also are important indirect impacts associated with climate change of concern. The International Panel on Climate Change (2001,

2007) noted that synergisms between the effects of climate change and other stressors pose the greatest threat to the world's biodiversity. Not surprisingly, climate change presents a serious threat to the continued persistence of NSO, especially when coupled with the already occurring impacts resulting from past and ongoing habitat loss, disease, predation, the invasion of the Barred Owl, and the inadequacy of state and federal regulatory mechanisms.

CONCLUSIONS

Since the NSO was listed in 1990, owl populations have continued a downward spiral, including in northern California. Many populations have been extirpated, others are been reduced dramatically, and threats are escalating region-wide as well as in California. The scientific evidence is clear that the owl is in danger of extinction throughout all or a significant portion of its range. Further, the road to recovery will not be easy. The NSO is facing a number of serious threats, especially on nonfederal lands where rates of logging are much higher than federal lands and regulatory mechanisms inadequate to reverse population declines. Responding to multiple threats is complicated given that threats may act individually, synergistically, and cumulatively. Thus, the result is that the NSO is facing increasing risks throughout its range and warrants listing under the CESA and this information, particularly the extensive and new studies cited herein, should be included in the states' status review and determination for listing under CESA.

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Appendix A (in press, Open J of Ecology)

EFFECTS OF FIRE AND COMMERCIAL THINNING ON FUTURE HABITAT OF THE NORTHERN SPOTTED OWL

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Running Title: Fire, thinning and spotted owls.

ABSTRACT

The Northern Spotted Owl (*Strix occidentalis caurina*) is an emblematic, threatened raptor associated with dense, late-successional forests in the Pacific Northwest, USA. Concerns over high-severity fire and reduced timber harvesting have led to programs to commercially thin forests, and this may occur within habitat designated as "critical" for spotted owls. However, thinning is only allowed under the U.S. Government spotted owl guidelines if the long-term benefits clearly outweigh adverse impacts. This possibility remains uncertain. Adverse impacts from commercial thinning may be caused by removal of key habitat elements and creation of forests that are more open than those likely to be occupied by spotted owls. Benefits of thinning may accrue through reduction in high-severity fire, yet whether the fire-reduction benefits accrue faster than the adverse impacts of reduced late-successional habitat from thinning remains an untested hypothesis. We found that rotations of severe fire in spotted owl habitat since 1996, the earliest date we could use, were 362 and 913 years for the two regions of interest: the Klamath and dry Cascades. We calculated the future amount of spotted owl habitat that may be maintained with these rates of high-severity fire and ongoing forest regrowth rates with and without commercial thinning. Over 40 years, habitat loss would be far greater than with no thinning because, under a "best case" scenario, thinning reduced 3.4 and 6.0 times more dense, late-successional forest than it prevented from burning in high-severity fire in the Klamath and dry Cascades, respectively. Even if rates of fire increase substantially, the requirement that the long-term benefits of commercial thinning clearly outweigh adverse impacts is not attainable with commercial thinning in spotted owl habitat. It is also becoming increasingly recognized that exclusion of high-severity fire may not benefit spotted owls in areas where owls evolved with reoccurring fires in the landscape.

KEY WORDS: Forest thinning; habitat loss; fire rotation, forest regrowth rate, future habitat, late-successional forest; policy implications; severe fire; spotted owl.

INTRODUCTION

Conservation of the emblematic Northern Spotted Owl (*Strix occidentalis* ssp. *caurina*) in the Pacific Northwest of North America has become a global example of balancing conflicting land management goals (DellaSala and Williams 2006). Concern over degradation of the owl's dense, late-successional forest habitat led to the 1994 Northwest Forest Plan (NWFP). The NWFP shifted management on ~100,000 km^2 of federal USA forestlands from an emphasis on resource extraction to embrace ecosystem management and biodiversity conservation goals. Under the NWFP, ~30% of federal lands traditionally managed for timber production were placed in late-successional reserves that emphasized conservation goals and limited timber harvesting (USFS/USDI 1994).

Over the last decade, managers and policy makers have become increasingly concerned about high-severity fire and reduced timber harvesting in NWFP dry forests (e.g., Spies *et al.* 2006, Power 2006, Thomas *et al.* 2006, Ager *et al.* 2007, USFWS 2011). Forest thinning has been viewed as a solution for controlling fires in dry forests throughout western North America (Agee and Skinner 2005, Stephens and Ruth 2005) and commercial criteria have been included to pursue timber harvest goals (Johnson and Franklin 2009, Franklin and Johnson 2012). Commercial thinning prescriptions currently being implemented under these criteria may remove up to one-half of forest basal area, and may also include patch cutting or small clear cuts (USDI 2011). Commercial thinning is now proceeding rapidly without a full understanding of the long-term risks.

For spotted owls, thinning and associated activities often remove or reduce key habitat features in direct proportion to the intensity of the commercial prescription. Key spotted owl habitat features that may be reduced or removed directly or indirectly include high tree density and canopy cover (King 1993, Pidgeon 1995), recently killed pines (*Pinus* spp.) and abundant snags (Pidgeon 1995), multiple tree layers, with abundant medium and small white fir (*Abies concolor*) or Douglas-fir (*Pseudotsuga menziesii*) (King 1993, Pidgeon 1995, Everett *et al.* 1997, Irwin *et al.* 2012), large volume of mature-sized down logs

(Pidgeon 1995), shrubs (King 1993, Pidgeon 1995, Irwin *et al.* 2012) and trees with heavy mistletoe infections (Hessburg *et al.* 2008), which are essential for spotted owl nesting (USFWS 2011). Thinning or contemporary harvest near the nest or activity center has been shown to displace Northern Spotted Owls (Forsman *et al.* 1984, King 1993, Hicks *et al.* 1999, Meiman *et al.* 2003). Telemetry studies on California Spotted Owls (*Strix occidentalis* ssp. *occidentalis*) in the Sierra Nevada found that owls avoided Defensible Fuel Profile Zones (an intensive thinning treatment) (USFS 2010). Unoccupied California Spotted Owl territories had a lower probability of re-occupancy after timber harvest, even when habitat alterations comprised <5% of a territory (Seamans and Gutiérrez 2007). In addition, Barred Owls (*S. varia*), which out-compete spotted owls (Dugger *et al.* 2011), use younger and more open forests compared to Northern Spotted Owls (Wiens 2012).

Studies also have found negative impacts of thinning to northern flying squirrels (*Glaucomys sabrinus*), the primary prey of Northern Spotted Owls in most of its range (Waters and Zabel 1995, Waters *et al.* 2000, Carey 2001, Ransome and Sullivan 2002, Gomez *et al.* 2003, Ransome *et al.* 2004, Bull *et al.* 2004, Meyer *et al.* 2007, Wilson 2008, Holloway and Smith 2011, Manning *et al.* 2012). Negative effects may persist for 15 years or longer (Wilson 2008). In addition, openings between trees from thinning may create barriers, due to predator avoidance, for flying squirrels to cross using its gliding locomotion (Manning *et al.* 2012). Thinning has also been found to have negative effects on the abundance of other main prey species for Northern Spotted Owls such as red-backed voles (*Myodes californicus*) (Suzuki and Hayes 2003) and woodrats (*Neotoma cinerea, N. fuscipes*) (Lehmkuhl *et al.* 2006).

Because of the many conflicts between thinning and spotted owl conservation, some authors have recommended that treatments aimed at controlling fire avoid spotted owl habitat and instead treat vegetation elsewhere that is the most flammable and strategic for accomplishing fuel treatment goals (Gaines *et al.* 2010). The 2011 Recovery Plan for the Northern Spotted Owl, the blueprint for management of this species on federal lands in the region (USFWS 2011), contains the proviso that long-term benefits to spotted owls of forest thinning treatments must *clearly outweigh* adverse impacts (USFWS 2011). The U.S. Fish and Wildlife agency that developed the plan suggested that benefits over time might accrue from a net increase in habitat because fire disturbances would be reduced (USFWS 2011). But whether the benefits would outweigh the impacts remains uncertain due to limitations of previous assessments.

Previous assessments of the efficacy of thinning treatments in reducing fire disturbances in spotted owl habitat (Wilson and Baker 1998, Lee and Irwin 2005, Roloff *et al.* 2005, 2012, Calkin *et al.* 2005, Hummel and Calkin 2005, Ager *et al.* 2007, Lehmkuhl *et al.* 2007) have not incorporated the probability of high-severity fires occurring during the treatment lifespan. The effect of this is to overestimate treatment efficacy in potentially controlling fire or fire behavior (Rhodes and Baker 2008). Nor have the effects of recruitment of dense, late-successional forest that act to offset loss from fire been included in prior assessments. In addition, impacts of the kind of commercial thinning treatments being implemented to address dry forest concerns have not been fully considered to the owl or its prey (e.g., Ager *et al.* 2007, Lehmkuhl *et al.* 2007, Roloff *et al.* 2012). Current commercial thinning prescriptions being implemented in dry forests specifically identify desired future conditions to be maintained (e.g. Johnson and Franklin 2009) that have basal area and other structural targets mostly well below the minimum levels that have been found in spotted owl nesting, roosting and foraging habitat (NRF) in dry forests. For example, basal area targets in a project in southwest Oregon designed to demonstrate the thinning prescriptions in dry forest spotted owl habitat were 13.75-27.5 m^2/ha (USDI 2011), while stands < 23 m^2/ha very rarely support spotted owl nesting territories (Buchanan and Irwin 1995). In addition, the Recovery Plan (USFWS 2011) permits thinning in core areas, but emphasizes treating areas outside of core areas, so there is a need for assessment of impacts outside core areas as well. Areas outside cores may be essential for foraging and be part of the breeding season home range. Furthermore, owls often move outside core areas (USFWS 2011). Lastly, available habitat outside existing cores may become important to owl recovery, particularly if spotted owls are displaced from higher quality habitat by Barred Owls (Dugger *et al.* 2011).

To assess whether benefits of commercial thinning outweigh adverse impacts to spotted owls in dry forests (USFWS 2011), quantitative assessments are needed that allow for direct assessment of the amounts of any dense, mature or late-successional habitat that would be reduced by both commercial prescriptions and severe fire. Accordingly, we calculated these amounts by projecting them over 40 years and incorporated into our calculations the effects of forest regrowth. We used empirical data on fire and forest regrowth from the potential habitat within the two dry forest regions where spotted owls occur, the Klamath and dry Cascades of California, Oregon, and Washington, that are subject to thinning. We analyzed each region separately using region-wide data. Conservation planning for spotted owls commonly occurs at the scale of these regions. For our thinning treatment, we chose a "best" scenario for minimizing the amount of dense, late-successional forest to be treated (Lehmkuhl *et al.* 2007); while we used an optimistic scenario for treatment efficacy, assuming that a 50% reduction in high-severity fire would occur (Ager *et al.* 2007). We also illustrate the effects of varying treatment amount and efficacy. To calculate rotations of severe fire in the forests of the study area, we used available fire data from a time period, 1996-2011, which includes exceptionally large, rare fire events. Our approach may be useful to managers interested in maintaining habitat for other species that rely on dense forests in fire-prone regions (Odion and Hanson 2013).

METHODS

Study area

We analyzed fire and forest recruitment trends in 19,000 km^2 of dry forests in the Klamath and 18,400 km^2 in the Cascades provinces. As in Hanson *et al.* (2009), we analyzed only late-successional, or "older" forests present in 1995, as mapped by Moeur *et al.* (2005). This is a small fraction of the dry forest regions. Our analysis was further restricted to federal lands. Mapping by Moeur *et al.* (2005) corresponds to mid-montane forest zones where Northern Spotted Owls occur. These montane forest zones include forests dominated mainly by true firs (*A. grandis, A. concolor*), Douglas-fir (*Pseudotsuga menziesii*), and Ponderosa pine (*P. ponderosa*), with mixed forests of Douglas-fir and white fir. Other conifers found in the central and northern Cascades in dry forests frequented by spotted owls are western hemlock (*Tsuga heterophylla*), western larch (*Larix occidentalis*), and limited amounts of western red cedar (*Thuja plicata*) and Engelmann spruce (*Picea engelmannii*). Forests in the Klamath are noted for high conifer diversity, with species such as incense cedar (*Calocedrus decurrens*) commonly found in the range of spotted owls. A variety of broad-leaved evergreen trees, such as madrone (*Arbutus menziesii*) and tanoak (*Lithocarpus densiflorus*) are also characteristic of these forests (Whittaker 1960).

Quantifying future habitat

We determined existing rates of dry-forest redevelopment following stand initiation in the forests of the study regions as delineated by Mouer *et al.* (2005) using the extensive U.S. Forest Service Forest Inventory and Analysis (FIA) forest monitoring data (http://www.fia.fs.fed.us/tools-data/). FIA is a monitoring system based on one permanent, random plot per ~2400 ha across forested lands. We excluded plots from forests not used by spotted owls (e.g. lodgepole pine, oak forest) and from non-conifer vegetation and non-federal lands. Most of these plots were already excluded by the mapping by Mouer *et al.* (2005) that delineated the study area.

An FIA plot consists of a 1-ha area. For tree measurements, this area is sub-sampled with four circular subplots that are 0.1 ha for large-tree sampling and 0.017 ha for smaller-tree sampling (defined by region). The diameter-at breast-height (dbh) and crown position of each tree and the ring count from two cores from dominant/codominant trees are measured in each subplot (USFS 2010). Stand age for an FIA plot is determined from the average of all ring counts from sub-plot samples, weighted by cover of sampled trees, and 8 years are added for estimated time to grow to breast height (1.4 m). We used live-tree dbh data to prepare regressions with stand age.

FIA data were available from 2001-2009, comprising 90% of the plots available within our study area. A total of 581 plots from the Klamath and 441 from the dry Cascades were considered, representing 13,944 and 10,680 km^2 in each region, respectively. The number would be higher, but we eliminated 139 plots in the Klamath and 141 in the Cascades that had different stand-initiation dates from different subplots of the main FIA plot. This situation occurs throughout the study area due to the patchy nature of mixed-severity fire. Including all the subplots as individual plots creates a larger sample size, but we chose not to do this because some individual locations would be overrepresented. Most importantly, both approaches lead to the same results.

We analyzed fire severity from 1996-2011 in late-successional, or "older" forests mapped by Moeur *et al.* (2005). For 1996-2008, we used the Monitoring Trends in Burn Severity (MTBS) (http://www.mtbs.gov/) data. We used the ordinal classification from MTBS, as MTBS analysts determine for each fire where significant thresholds exist in digital prefire and postfire images, supplemented with plot data and analyst experience with fire effects. In plot data, a composite burn index that sums mortality by vegetation stratum is used to identify high fire severity (see http://www.mtbs.gov/). For 2009-2011, we obtained U.S. Forest Service digital data (http://www.fs.fed.us/postfirevegcondition) and classified these data following Miller and Thode (2007). We could not use pre-1996 MTBS fire severity data because the pre-burn map of spotted owl forest habitat is from 1995 (Moeur *et al.* 2005). From severity data we calculated high-severity fire rotation (FR^{hs}), the expected time to severely burn an area equivalent to the area of interest once, or the landscape mean interval for severe fire (Baker 2009).

We calculated annual high-severity fire and forest regrowth rates to future proportions for early-, mid- and mature or late-successional forests, denoted herein by "E," "M," and "L," respectively, using annual time steps. We defined late-successional forests by selecting a value, 27.5 m^2/ha. This amount corresponds with the maximum basal area that would be left according to currently implemented thinning prescriptions (USDI 2011). This is somewhat higher than the minimum basal area where spotted owls have been found to nest in dry forests. For example, the mean value minus one standard deviation in all the dry forest stands studied by Buchanan *et al.* (1995) was 23 m^2/ha. However, we did not want to identify the rate of regrowth to the very minimum basal area that constitutes habitat, but regrowth to a basal area more likely to function as habitat. Mid- and early-successional forests were defined as 13.5-27.5 and <13.5 m^2/ha tree basal area, respectively. We separated mid-successional from early-successional forest because, mid-successional forests may be included in thinning treatments, but early-successional forests may not. Thinned forest ("T") was our fourth vegetation state. The forest states are diagramed in Fig. 1. The proportion of each state in the landscape at time *t,* defined a vector (P_t^E, P_t^M, P_t^T, P_t^L). Transition probabilities ϕ_t^{rs} equaled the probability that any portion of state *r* at time *t* transitions to state *s* at time *t* + 1, allowing calculation of future amounts of each forest type using the following equation:

$$\begin{bmatrix} \phi_t^{EE} & \phi_t^{ME} & \phi_t^{TE} & \phi_t^{LE} \\ \phi_t^{EM} & \phi_t^{MM} & \phi_t^{TM} & \phi_t^{LM} \\ \phi_t^{ET} & \phi_t^{MT} & \phi_t^{TT} & \phi_t^{LT} \\ \phi_t^{EL} & \phi_t^{ML} & \phi_t^{TL} & \phi_t^{LL} \end{bmatrix} \begin{bmatrix} P_t^E \\ P_t^M \\ P_t^T \\ P_t^L \end{bmatrix} = \begin{bmatrix} P_{t+1}^E \\ P_{t+1}^M \\ P_{t+1}^T \\ P_{t+1}^L \end{bmatrix} \begin{bmatrix} P_{t+1}^E \\ P_{t+1}^M \\ P_{t+1}^T \\ P_{t+1}^L \end{bmatrix} = \begin{bmatrix} \Psi_t^{EE} & \Psi_t^{ME} & \Psi_t^{TE} & \Psi_t^{LE} \\ \Psi_t^{EM} & \Psi_t^{MM} & \Psi_t^{TM} & \Psi_t^{LM} \\ \Psi_t^{ET} & \Psi_t^{MT} & \Psi_t^{TT} & \Psi_t^{LT} \\ \Psi_t^{EL} & \Psi_t^{ML} & \Psi_t^{TL} & \Psi_t^{LL} \end{bmatrix} \begin{bmatrix} P_t^E \\ P_t^M \\ P_t^T \\ P_t^L \end{bmatrix} \qquad \text{Eq. 1}$$

The initial proportions, $P_{t=0}^{E-L}$ of the three natural-forest states were from the FIA basal-area analyses, with thinned forests considered zero for simplicity and because of lack of data. The annual transition from mid- and late- to early-successional forest from high-severity fire (ϕ_t^{LE}, ϕ_t^{ME}) was $1/FR^{hs}$. Early-successional forests also burned at this rate (ϕ_t^{EE}). Annual rates of forest redevelopment were from the inverse of the growth period ($1/G^{EM}$) to reach 13.5 m^2/ha live-tree basal area, or to grow from 13.5 to 27.5 m^2/ha live-tree basal area ($1/G^{ML}$), calculated from the regression of live basal area on age (see results). Lower-severity fire can reduce basal area from >27.5 m^2/ha basal area to <27.5 m^2/ha. However, this transition is already considered in the regrowth rate, which also incorporates the effects of lower-severity fires that have occurred on rates of forest redevelopment. Because natural disturbances that may temporarily lower basal area are captured in the transitions from early- to late-successional forest, the transitions from late to mid-successional forest and mid- to early-successional forest were set to zero. Transition rates to thinned forest were based on treatment within 20 years, beginning in year $t + 1$, of the mid- and late-successional forests present at $t = 0$ (see Table 1 for annual rate). We used these transitions (Table 1) and Eq. 1 to project forward 40 years. We chose this time interval because it represents one cycle of thinning and forest recovery.

According to an analysis of a spotted owl landscape by Lehmkuhl *et al.* (2007), a "best" scenario for minimizing the short-term adverse impacts of thinning while reducing fire frequency and severity was one that treated only 22% of the landscape, and limited thinning in nesting, roosting, and foraging habitat to 21% of the area of this habitat. We used this prescription in our calculations to illustrate the effects under a best-case scenario. In our calculations, the amount of mid-successional forest thinning differed between the two regions because amounts of both mid- and late-successional forests were not the same. We also considered the effects of treating from 0 to 45% of forests, holding constant the proportions of treatments that were in late-successional vs. mid-successional forests.

We assumed that there would be no high-severity fire in treated forests over the treatment lifespan. We additionally assumed that thinning 22% of the landscape would lower the amount of high-severity fire in the unthinned landscape by half. This is based on the findings of Ager *et al.* (2007) who simulated the effects of wildfire ignitions following strategic thinning treatments in a spotted owl landscape. When <22% of the landscape was affected at any given time (such as any time prior to year 20 when the full treatment would be incomplete, or after one-time treatments began to recover, or for scenarios with <22% of the landscape treated) the same ratio of area treated to reduction in high-severity fire (22% treat: 50% reduction in fire) was used. Ager *et al.* (2007) found little additional effect of treatments in reducing wildfires as treatment level increased beyond 20%, so we did not calculate greater reductions in fire as treatment levels went from 22-45%. However, we additionally calculated future habitat amounts as a function of fire rotation to evaluate the effects of varying treatment efficacy, in which case we did calculate the reduced amount of habitat burned severely. This amount is the dependent variable in our summary figures. Treatment lifespan was assumed to be 20 years (Rhodes and Baker 2008) for "one-time thinning," or maintained in perpetuity over the 40 years for "maintained."

The only owl habitat we considered for impacts from thinning was suitable nesting, roosting, and foraging (so called NRF habitat). Because treatments aimed at demonstrating the type of thinning to be implemented in spotted owl habitat reduce basal area down to 13.75-27.5 m^2/ha, mostly well-below the minimum amounts for NRF habitat (Pidgeon 1995, Buchanan and Irwin 1998, LeHaye and Gutiérrez 1999), and because treated forests also have reduced amounts of key habitat features like multi-canopy structure, down wood, small firs and mistletoe infections, the area affected by these treatments will largely correspond to the amount of habitat lost. Thinning may also render adjacent, unthinned forest unsuitable or less suitable (Seamans and Gutiérrez 2007), but we did not account for this effect. The lifespan for thinning treatments that we used was 20 years for one-time thinning (Rhodes and Baker 2008), and 40 years for maintained treatments. Transition from late- to early-successional vegetation due to high-severity fire also was considered habitat loss. This may overestimate the impacts of fire on Northern Spotted Owl foraging habitat (Bond *et al.* 2009, USFWS 2011), but the assumption is largely irrelevant due to the low rates of high-severity fire in both study regions in relation to forest regrowth, as described next.

RESULTS

We found a highly significant relationship between live-tree basal area and stand age in both regions (Figures 2a-b, Klamath n = 442, dry Cascades n = 304). Much of the variance in the plot data was caused by a modest number of relatively old stands that had much lower basal area for their age than did other plots. The amount of time following disturbance needed for regenerating forests to reach live-tree basal area >27.5 m^2/ha was 77 and 90 years, respectively, for the Klamath and dry Cascades (Table 2).

Using the MTBS data, the rotation for high-severity fire from 1996-2011 was 362 to 913 years in the Klamath and dry Cascades, respectively (Table 2). At these rates, a total of 1,221 and 325 km^2 of high-severity fire would occur in Klamath and dry Cascades late-successional forests, respectively, in 40 years. With annual regrowth rates of late-successional forests that were 4.5 to >10 times greater than the rates of fire disturbances (i.e. (1/77)/(1/362) for the Klamath and (1/89)/(1/913) for the dry Cascades, and no disturbances other than fire, late-successional forests would eventually come to occupy 83% of the potential forested area in the Klamath and 91% in the Cascades. Thus, over 40 years, late-successional forests in the Klamath increased slightly over their current amount of 77% of the forested landscape FIA plots to 81% or from about 10,668 km^2 to 11,335 km^2 (Fig. 3a). In the dry Cascades, where late-successional forests were 59% of the forested landscape FIA plots, they increased relatively rapidly to 77% of the forested landscape, or from 6,253 km^2 to 8,234 km^2 in 40 years (Fig. 4a).

Simulated thinning of 21% of dense, late-successional forest of the Klamath landscape meant that a total of 2,225 km^2 would be reduced, while treatments in mid-successional forests would cover 840 km^2 to reach a treatment level of 22 percent of the whole landscape (which included some early-successional forest). After the one-time thinning, late-successional forests returned to slightly lower amounts than occurred without thinning after 40 years (Fig. 3a). The net effect of the one-time thinning was to reduce late-successional habitat by 10.7% over the 40-year period, or from an average of 11,086 km^2 to 9,996 km^2 over 40 years (i.e., 1,090 km^2 less each year on average, Fig 3b). The amount of dense, late-successional forest that was prevented from burning at high severity was 16 km^2/year, resulting in 320 km^2 of dense, late-successional forest, which would otherwise have been transformed into early-successional forest, in each year on average over the 40-year period. Therefore, in this scenario, thinning reduced 3.4 times more late-successional forest than it increased. The maintained treatment reduced habitat by 15.3%, from 11,086 km^2 on average over 40 years to 9,396 km^2 (i.e., 1,690 km^2 less each year on average, Fig. 3c). In both cases, 13% of the habitat loss was from thinning in mid-successional forest that prevented or slowed these forests from developing into dense, late-successional forest. The amount of dense, late-successional forest that was prevented from burning at high severity was 20 km^2/year, resulting in 400 km^2 of dense, late-successional forest, which would otherwise have been transformed into early-successional forest, in each year on average over the 40-year period. Therefore, the combination of thinning and maintenance reduced 4.2 times more late-successional forest than it increased.

In the Cascades, to treat 22% of the landscape, the thinning scenario targeted 1,313 km^2 of dense, late-successional forest, and 1,036 km^2 of mid-successional forest. After the one-time thinning, late-successional forests again returned to slightly lower amounts than occurred without thinning after 40 years (Fig. 4a). The net effect of the one-time thinning treatment over 40 years was to reduce dense, late-successional forest by an average level of 11.1% (836 km^2 less each year on average, Fig. 4b). The amount of dense, late-successional forest that was prevented from burning at high severity from the one time treatment was 3.5 km^2/year, resulting in 140 km^2 of dense, late-successional forest, which would otherwise have been transformed into early-successional forest, in each year on average over the 40-year period. Therefore, thinning reduced 6.0 times more late-successional forest than it increased. The maintained treatment reduced dense, late-successional forest by an average of 16.4% (1,212 km^2 less each year on average, Figs. 4c). Of this reduction, 30% was from the indirect effect of thinning in mid-successional forests, more of which were treated in the Cascades scenario. The amount of dense, late-successional forest that was prevented from burning at high severity from the maintained treatment scenario was 4.5 km^2/year, resulting in 180 km^2 of dense, late-successional forest, which would otherwise have been transformed into early-successional forest, in each year on average over the 40-year period. Therefore, the combination of thinning and maintenance reduced 6.7 times more late-successional forest than it increased.

As treatment level increased from 11 to 22%, habitat loss doubled (Fig. 5). With 22% of the landscape treated, the effect of reducing fire by 50% in the rest of the landscape was reached, and there was no further reduction in fire with increasing treatment amount. With less fire prevented per km^2 treated, the rate of habitat loss increased as treatment went from 22 to 45% of the landscape.

We also assessed the effect of holding treatment level constant and varying the efficacy of treatments. Even if treatment efficacy was considerably greater than we assumed and rotations of high-severity fire substantially longer than twice their current length, the amount of dense, late-successional forest habitat that would be reduced due to thinning would only be slightly lower (Figs. 6a-b). With complete elimination of fire over 40 years as a result of treatments, the amount of dense, late-successional forest would be 9-10% less than with no treatment. This becomes a large amount of habitat loss over time.

DISCUSSION

We found that the habitat recruitment rate exceeded the rate of severe fire by a factor of 4.5 in the Klamath and 10 in the dry Cascades, leading to a deterministic increase in dense forest habitat over time, assuming no other disturbance events. In contrast, previous assessments of fire on spotted owls have not explicitly considered fire and forest regrowth rates (Wilson and Baker 1998, Lee and Irwin 2005, Roloff *et al.* 2005, 2012, Calkin *et al.* 2005, Hummel and Calkin 2005, Ager *et al.* 2007, Lehmkuhl *et al.* 2007). Not including the probability of high-severity fire, which is low, leads to highly inflated projections of the effects of thinning versus not thinning on high-severity fire (Rhodes and Baker 2008, Campbell et al. 2012).

Our calculations of thinning effects included rates of forest regrowth along with high-severity fire. The calculations illustrate how the requirement that the long-term benefits of thinning clearly outweigh adverse impacts (USFWS 2011) is not attainable as long as treatments have adverse impacts on spotted owl habitat. This is because the amount of dense, late-successional forest that might be prevented from burning severely would be a fraction of the area that would be thinned. Under our "best case" scenario, thinning reduced dense, late-successional forest by 3.4 and 6.0 times more than it prevented such forest from experiencing high-severity fire in the Klamath and dry Cascades, respectively. This would not be a concern if thinning effects were neutral, but the commercial thinning prescriptions being implemented call for forests with basal area reduced by nearly half to 13.5-27.5 m^2/ha, which is mostly well below the minimum level known to function as nesting and roosting habitat (ca. 23 m^2/ha) (Buchanan *et al.* 2003). Thus, if dense forests are subjected to these treatments, much of the impacted area would no longer have minimum basal area needed to function as nesting and roosting habitat. Even an immediate doubling of fire rates due to climate change or other factors would result in far less habitat affected by high-severity fire than thinning. In addition, much of the high-severity fire might occur regardless of thinning, especially if the efficacy of thinning in reducing high-severity fire is reduced as fire becomes more controlled by climate and weather (Cruz and Alexander 2010). Clearly, the strategy of trying to maintain more dense, late-successional forest habitat by reducing fire does not work if the method for reducing fire adversely affects far more of this forest habitat than would high-severity fire, and the high-severity fire might occur anyway because it is largely controlled by climate and weather.

There may be silvicultural treatments that can be done in spotted owl habitat that may reduce adverse impacts. For example, thinning that maintains at least 23-27.5 m^2 ha basal area. However, given that key habitat elements such as small trees, down wood, and likely some intermediate-sized trees are going to be targeted in any forest fuel reduction treatment, it appears unlikely that any conventional fuels reduction treatment in spotted owl habitat would not have at least some adverse impacts. This is supported by research on thinning that was often less intensive than commercial thinning prescriptions. This research showed negative impacts on spotted owls or their prey, as summarized in our introduction (Waters and Zabel 1995, Waters *et al.* 2000, Carey 2001, Ransome and Sullivan 2002, Gomez *et al.* 2003, Suzuki and Hayes 2003, Ransome *et al.* 2004, Bull *et al.* 2004, Lehmkuhl *et al.* 2006, Meyer *et al.* 2007, Wilson

2010, Holloway and Smith 2011, Manning *et al.* 2012), and how spotted owls have been displaced by even very limited amounts of thinning or contemporary harvest near the nest or activity center (Forsman *et al.* 1984, King 1993, Hicks *et al.* 1999, Meiman *et al.* 2003, Seamans and Gutiérrez 2007). Even if adverse impacts were quite modest, the amount of dense, late-successional forest that might be prevented from experiencing high-severity fire is so much smaller than the area that would be treated in an effort to accomplish this reduction in fire, that the net impact of the thinning would still be much greater. In addition, it is becoming increasingly less clear whether a reduction in high-severity fire below current rates would necessarily be beneficial to spotted owls. The dry forests in which spotted owls are found were historically characterized by mixed-severity fires (see Hessburg et al. (2007) and Baker (2012) for historic fire in the dry Cascades of Washington and Oregon, Beaty and Taylor (2001) and Bekker and Taylor (2001, 2010) for the California Cascades, and Wills and Stuart (1994), and Taylor and Skinner (1998, 2003) for the Klamath). Recent research suggests that this historic fire may have neutral and beneficial effects to spotted owls.

Studies on the effects of fire on spotted owls are few and often focused on other owl subspecies and some studies are confounded by post-fire logging effects (Clark *et al.* 2013). Nonetheless, it has long been known that fire in woody vegetation causes an increase in small rodent populations and consequently raptor populations (Lawrence 1966), and studies on spotted owls and fire where no logging occurred suggest that high-severity fire at current rates may confer benefits or be neutral. Bond *et al.* (2009) found that California Spotted Owls in the Sierra Nevada preferentially foraged in severely burned forests more than unburned forests within about 1.5 km of a core-use area. The percentage of high-severity fire in burned Mexican Spotted Owl (*Strix occidentalis* ssp. *lucida*) sites had no significant influence (Jenness *et al.* 2004). Roberts *et al.* (2011) found no support for an occupancy model for California Spotted Owls that distinguished between burned and unburned sites in unmanaged forests; the mean "owl survey area" that burned at high-severity was 12%, with one survey area experiencing up to 52% high-severity fire, which is almost three times the current amount of severe fire in owl habitat, according the MTBS data. In a longer-term (1997-2007) study of California Spotted Owl site-occupancy dynamics throughout the Sierra Nevada, high-severity fire that burned on average 32% of forested vegetation around nests and core roosts had no significant effect on extinction or colonization probabilities, and overall occupancy probabilities were slightly higher in mixed-severity burned areas than in unburned forest (Lee *et al.* 2012), while other research found no significant difference in home range size between mixed-severity fire areas and unburned forest (Bond *et al.* 2013). Studies on reproduction in occupied sites of all three spotted owl subspecies indicated no difference between unburned sites and mixed-severity burned sites (excluding burn out areas created by fire suppression operations) (Jenness *et al.* 2004), or in some cases reproduction may have been greater in burned sites (Bond *et al.* 2002, Roberts 2008). The longer-term value of fire disturbances is in the creation of landscape heterogeneity with inclusions of young stands, improving habitat at the landscape scale, as well its role in creating snags, large down logs, shrub regeneration and other key elements of the highest quality spotted owl habitat at the territory scale (Franklin *et al.* 2000). No assessments of fire and thinning effects on spotted owls, including this one, have accounted for any potential beneficial effects of mixed-severity fire, nor the potential negative effects of lack of mixed-severity fire in treated areas.

While much of the concern about fire and thinning in dry forests of the Pacific Northwest has focused on spotted owls, it may also apply to other biota associated with dense, old forests, including species of conservation concern, such as Pacific fisher (*Martes pennanti pacifica*), which research indicates may benefit from mixed-severity fire (Hanson 2013), the Northern Goshawk (*Accipiter gentilis*), and, following fire, the Black-backed Woodpecker (*Picoides arcticus*), which depends upon higher-severity fire in dense, older forest (Odion and Hanson 2013). Like the spotted owl, studies have documented that this woodpecker is also negatively affected by thinning (Hutto 2008). Also, like the spotted owl, the Back-backed Woodpecker, Pacific Fisher and Northern Goshawk occur in forests where the historic fire regime was not low-severity. Modeling for the fisher, similar to modeling for the spotted owl, has not used the actual rates of high-severity fire and forest regrowth to assess possible impacts of fire, and has assumed that fire represents a loss of fisher habitat (Scheller *et al.* 2011), contrary to more recent empirical findings (Hanson 2013). Not including the actual probability of fire leads to considerably inflated projections of the effects of thinning vs. not thinning in reducing high-severity fire (Rhodes and Baker 2008, Campbell *et al*. 2012). Our findings highlight the need to be cautious about conclusions that thinning treatments are needed for species found in dense forest and that they will not have unintended consequences (e.g., Stephens *et al.* 2012) until long-term, cumulative impacts are better understood. As we found with spotted owls, long-term and unintended consequences may be substantial for species that rely on dense, late-successional forests, especially when these species are sensitive to small amounts of thinning in their territory.

CONCLUSIONS

We used a quantitative approach that, unlike others, accounted for rates of high-severity fire and forest recruitment, allowing assessment of future amounts of spotted owl habitat at current rates of fire, with and without thinning. We found that the long-term benefits of commercial thinning would not clearly outweigh adverse impacts, even if much more fire occurs in the future. This conclusion applies even if adverse impacts of treatments are quite modest because of the vastly larger area that would need to be treated compared to area of high-severity fire that might be reduced by thinning. Moreover, our results indicate that, even if a longer time interval is analyzed (e.g., 100 years), the declines in dense, late-successional habitat due to thinning would not flatten, as long as thinning is reoccurring. Thus, where spotted owl management goals take precedence, the best strategy for maintaining habitat will be to avoid thinning treatments that have adverse impacts in spotted owl habitat or potential habitat (Gaines *et al.* 2010). There is ample area outside of existing or potential spotted owl habitat where managers wishing to suppress fire behavior or extent may focus their efforts without directly impacting spotted owls (Gaines *et al.* 2010), such as in areas adjacent to homes or in dense conifer plantations with high fuel hazards (Odion *et al.* 2004). In addition, there are management approaches that may be more effective than thinning in helping accomplish these fire prevention goals, such as controlling human-caused fire ignitions (Cary *et* *al.* 2009). Lastly, emerging research suggests that fire is not the threat it has been assumed to be for spotted owls, suggesting that, rather than management that focuses on suppressing fire behavior, other, no regrets active management may be more appropriate (Hanson *et al.* 2010). Research is needed to determine if these findings might apply to other species that are characteristic of dense forests, particularly given the widespread and growing emphasis on thinning as a management tool for suppressing wildland fires.

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Table 1. Annual transition probabilities used in transition matrices for each scenario analyzed for dry provinces within the range of the Northern Spotted Owl. FR^{hs} is the high-severity fire rotation. G is the time required for stands to grow from early to mid- (EM) or mid- to late-successional (ML) forest. P is the proportion of the landscape in E = early successional forest, M = mid-successional forest, and L = late-successional forest. K = Klamath, C = Cascades.

Transition probabilities	No treat	Treat 20% maintain	Treat 20% recover
ϕ_t^{LE}	$1/FR^{hs}$	$1/FR^{hs}$	$1/FR^{hs}$
ϕ_t^{EM}	$1/G^{EM}$	$1/G^{EM}$	$1/G^{EM}$
ϕ_t^{ME}	$2/FR^{hs}$	$2/FR^{hs}$	$2/FR^{hs}$
ϕ_t^{ML}	$1/G^{ML}$	$1/G^{ML}$	$1/G^{ML}$
ϕ_t^{MT*}	0	K = 0.0315 C = 0.0273	$K = 0.0315(P^{M}_{1,20})$ $C = 0.0273(P^{M}_{1,20})$
$\phi_t^{TM\dagger}$	0	0	$K = 0.0315(P^{M}_{1,20})$ $C = 0.0273(P^{M}_{1,20})$
ϕ_t^{TE}	0	0	0
$\phi_t^{TL\dagger}$	0	0	$K = 0.0114(\ P^{L}_{1,20})$ $C = 0.0105(\ P^{L}_{1,20})$
ϕ_t^{LT*}	0	K = 0.0114 C = 0.0105	$K = 0.0114(\ +P^{L}_{1,20})$ $C = 0.0105(\ +P^{L}_{1,20})$

[a]Only in effect for the first 20 years.
[b]Does not take effect until after 20 years.

Table 2. Forest Inventory and Analysis (FIA) plot parameters for the Klamath and dry Cascades provinces, California, Oregon, and Washington, based on most recent survey data from 2001-2009. Also shown are the amounts of time after fire that is takes forest to regrow to the specified live basal area (BA) thresholds using the regression equations shown in Figures 2a-b.

[a]These plots have 2 or more stand ages associated with them due to different disturbance histories within the main FIA plot.

[a]These plots have 2 or more stand ages associated with them due to different disturbance histories within the main FIA plot.

Entity	Klamath	Dry Cascades
Number of plots (total)	581	445
Number of plots excluded from analysis†	139	141
Initial ($P^{E}_{t=0}$) early-successional forest (%)	9	14.5
Initial ($P^{M}_{t=0}$) mid-successional forest (%)	14.4	26.9
Initial ($P^{L}_{t=0}$) late-successional forest (%)	76.6	55.6
Regrowth period, 0-13.5 m^2/ha live BA (yrs)	44	53
Regrowth period, 13.5-27.5 m^2/ha live BA (yrs)	32	36
Regrowth period, 0-27.5 m^2/ha live BA (yrs)	76	89
High-severity fire rotation	362	913

†These plots have 2 or more stand ages associated with them due to different-aged subplotswithin the main FIA plot.

FIGURE LEGENDS

Figure 1. State (boxes) and transition (arrows) model for dry Pacific Northwest Forest vegetation with fire disturbances and thinning. Variables are the transition rates between states indicated by the associated arrow.

Figure 2a-b. Scatterplots of live-tree basal area per hectare and stand age from US Forest Service FIA data for the A. Klamath region and B. dry Cascades region.

Figure 3a-c. Amounts of the four forest types (early-, mid-, late-successional, and thinned) in the landscape over a 40-year period based on the states shown in (Fig. 1) and transition rates (Table 2) for the Klamath province, California, and Oregon, and the following scenarios: A) no treatment; B) one-time treatment of 21% of late-successional forests (>27.5 m^2/ha live-tree basal area) and 42% of mid-successional forests (= total of 22% of landscape treated) followed by recovery in 20 years to late-successional forest; C) treatment of 21% of late-successional forests (>27.5 m^2/ha live-tree basal area) and 42% of mid-successional (= total of 22% of landscape treated) forests with future maintenance. We converted proportions of forest types from modeling output to km^2 using the area estimate from FIA for the Klamath study region.

Figure 4a-c. Amounts of the four forest types (early-, mid-, late-successional, and thinned) in the landscape over a 40-year period based on the states in (Fig. 1) and transition rates (Table 2) for the dry Cascades province, California, Oregon, and Washington and the following scenarios: A) no treatment; B) one time treatment of 21% of late-successional forests (>27.5 m^2/ha live tree basal area) and 36% of mid-successional forests (=22% of landscape treated) followed by recovery in 20 years to late-successional forest; C) treatment of 21% of late-successional forests (>27.5 m^2/ha live tree basal area) and 36% of mid-successional forests (=22% of landscape treated) in perpetuity. We converted proportions of forest types from modeling output to km^2 using the area estimate from FIA for the dry Cascades study region.

Figure 5. Net amount of habitat lost over 40 years compared to the no-treatment scenario as a function of treatment of 0-44% of the landscape. The amount of late-successional forest treated was held constant at 21% of the area of this forest, except at very low levels of treatment. The amount of mid-successional forest treated varied from zero at very low treatment levels, to a large proportion of the mid-successional forests when 44% of the landscape was treated, particularly in the Klamath region.

Figure 6a-b. Amount of forest habitat in the range of the Northern Spotted Owl in the A. Klamath, and B. dry Cascades 40 years in the future as a function of the average high severity rotation over that time period.

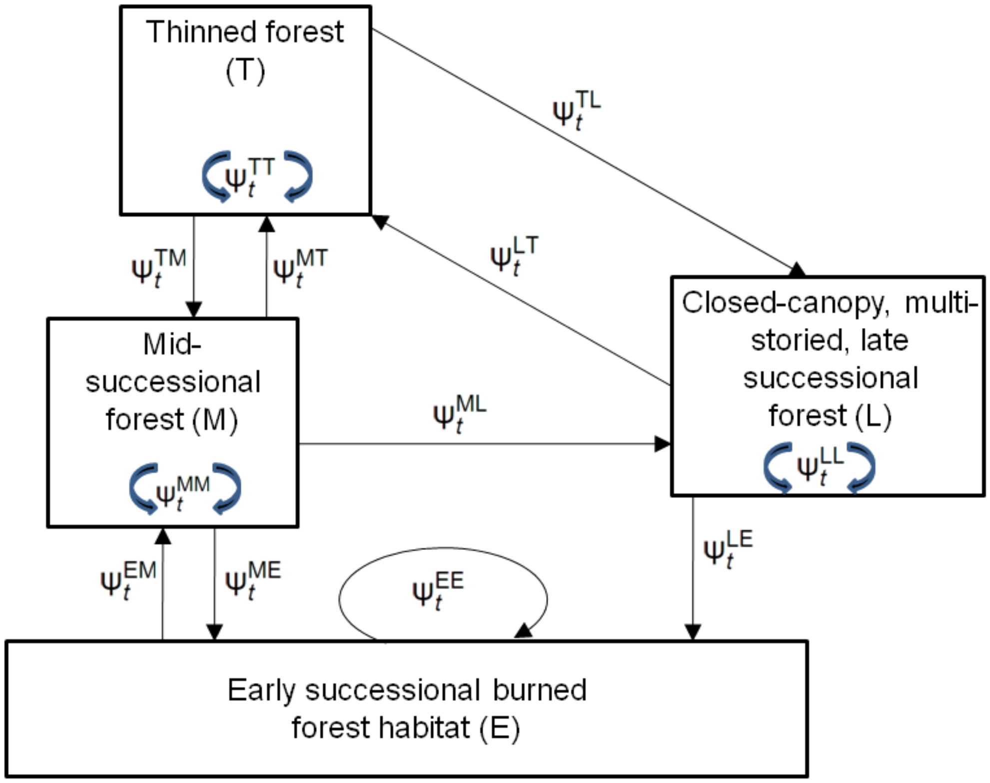

Thinned forest (T)
Ψ_t^{TT}
Ψ_t^{TL}
Ψ_t^{TM}
Ψ_t^{MT}
Ψ_t^{LT}
Closed-canopy, multi-storied, late successional forest (L)
Ψ_t^{LL}
Mid-successional forest (M)
Ψ_t^{ML}
Ψ_t^{MM}
Ψ_t^{EM}
Ψ_t^{ME}
Ψ_t^{EE}
Ψ_t^{LE}
Early successional burned forest habitat (E)

Figure 2

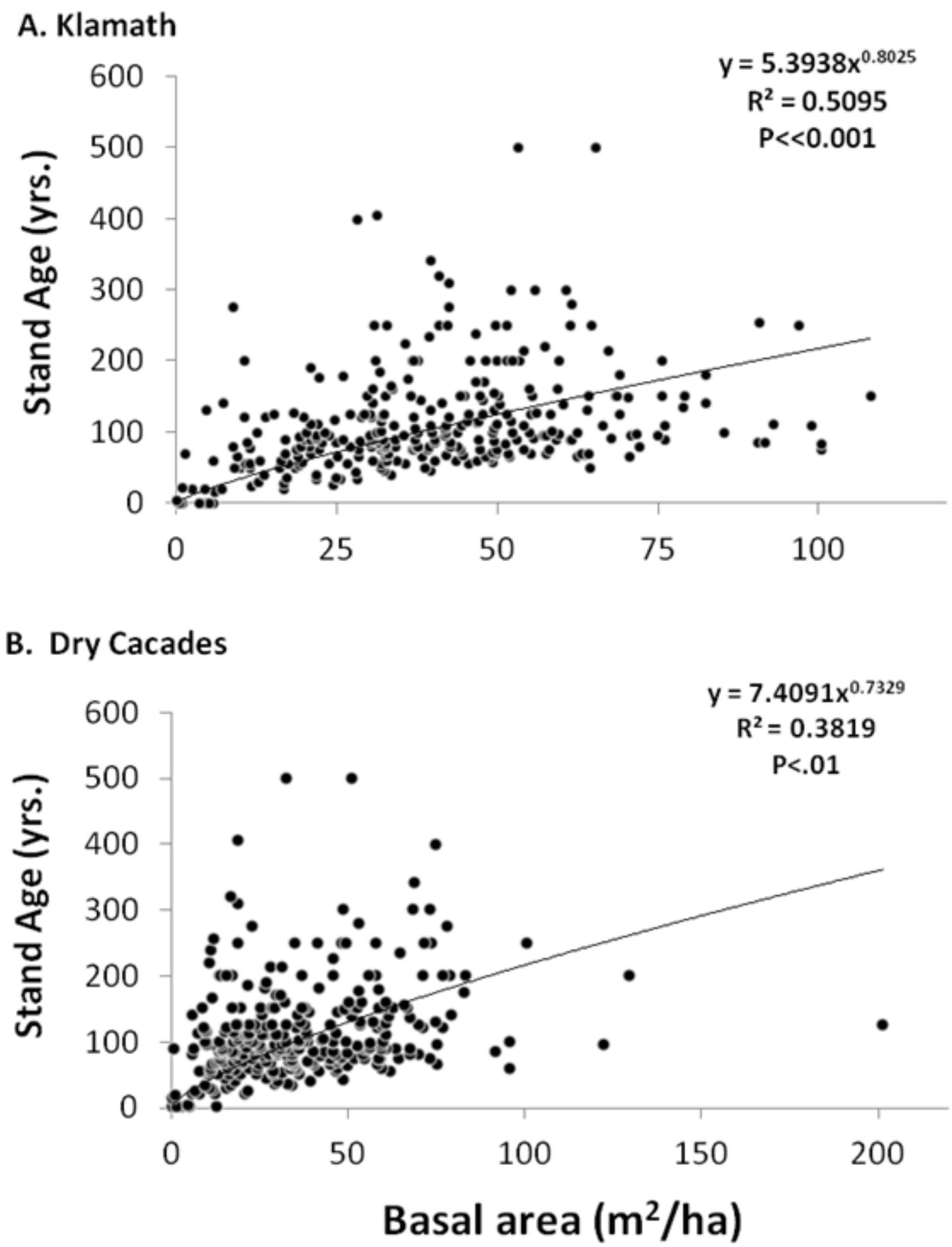

A. Klamath
y = 5.3938x^0.8025
R² = 0.5095
P<<0.001
Stand Age (yrs.)
0
100
200
300
400
500
600
0
25
50
75
100
B. Dry Cacades
y = 7.4091x^0.7329
R² = 0.3819
P<.01
Stand Age (yrs.)
0
100
200
300
400
500
600
0
50
100
150
200
Basal area (m²/ha)

Figure 3

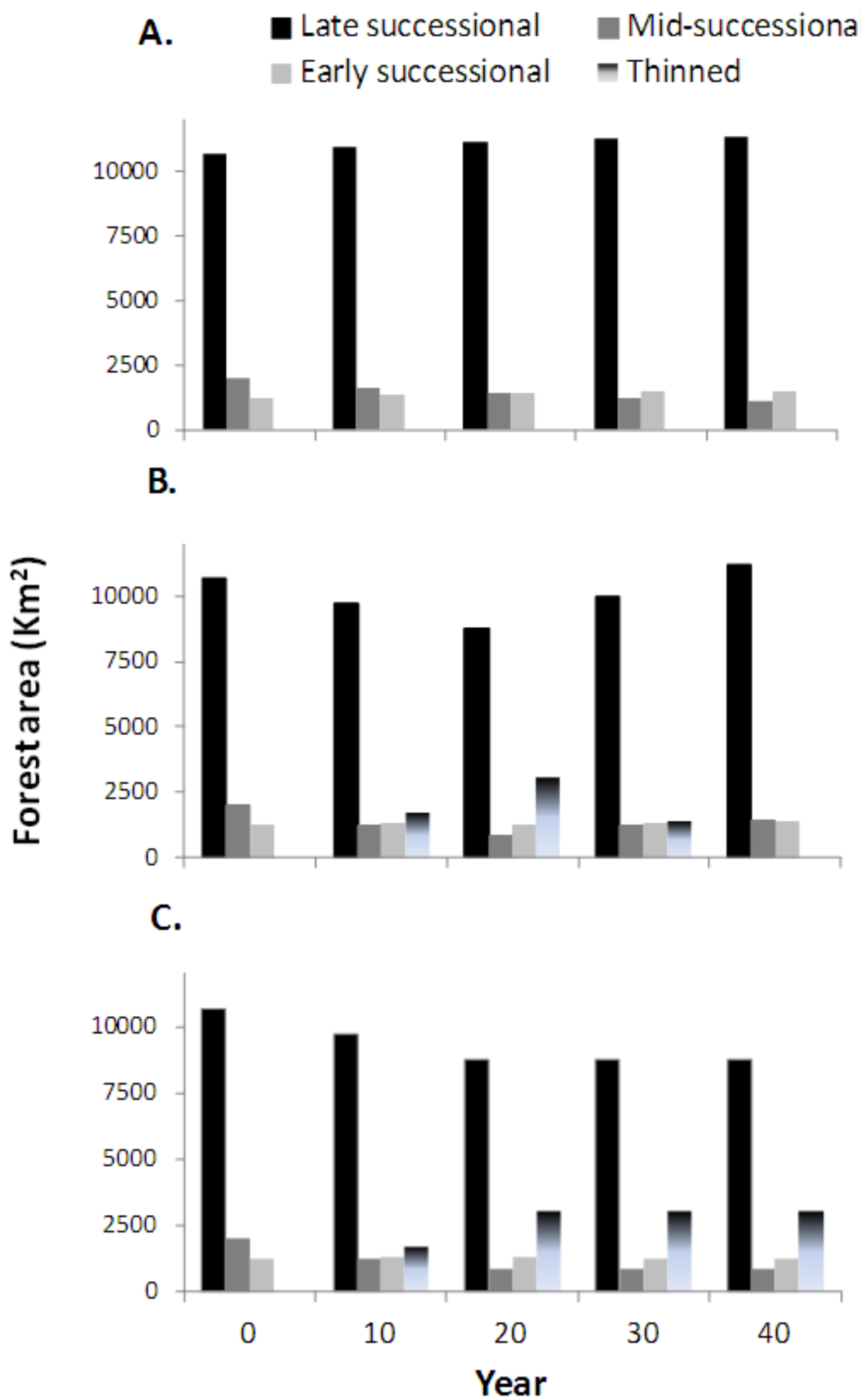
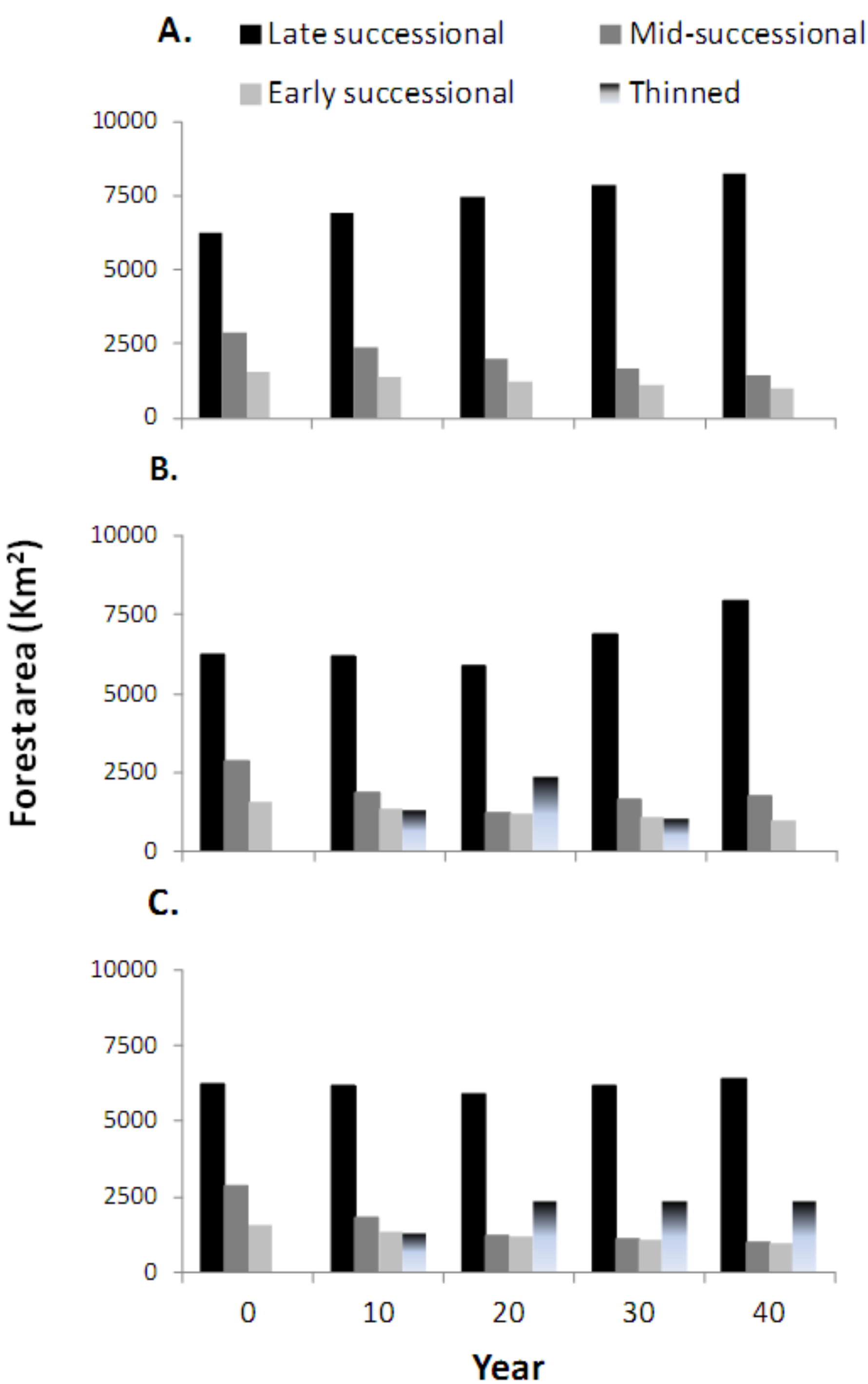
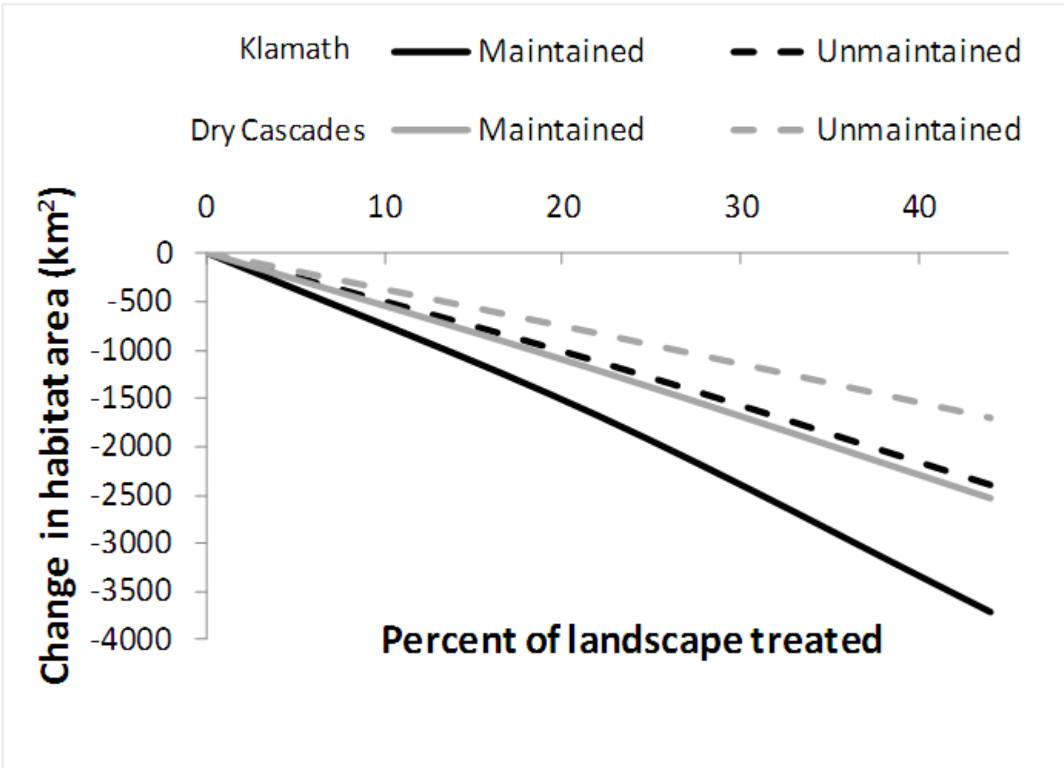
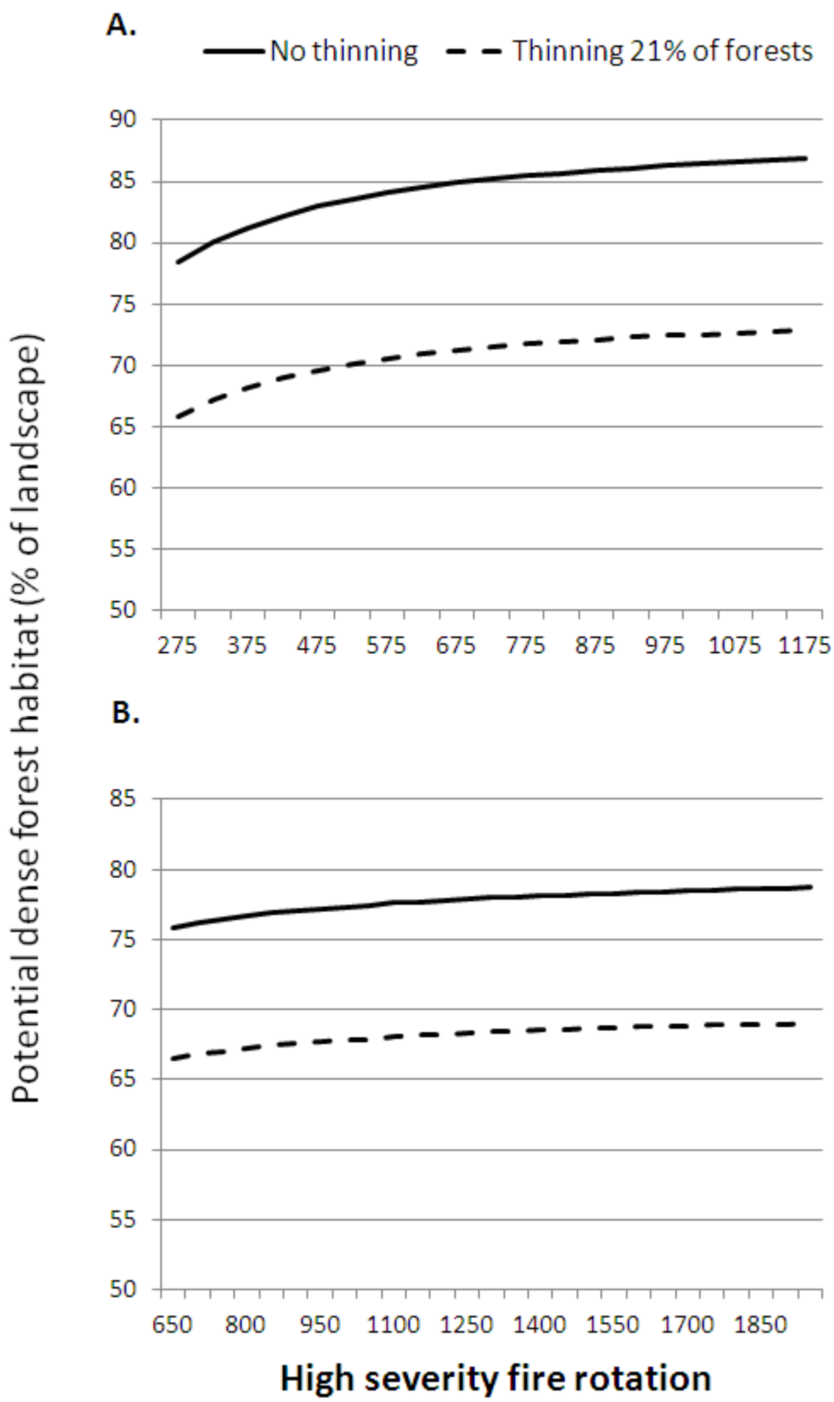

A.
Late successional
Mid-successional
Early successional
Thinned
B.
C.
Forest area (Km²)
10000
7500
5000
2500
0
0
10
20
30
40
Year

Figure 4


A.
Late successional
Mid-successional
Early successional
Thinned
B.
C.
10000
7500
5000
2500
0
Forest area (Km²)
0
10
20
30
40
Year


Klamath
Maintained
Unmaintained
Dry Cascades
Maintained
Unmaintained
0
10
20
30
40
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
Change in habitat area (km²)
Percent of landscape treated


A.
No thinning
Thinning 21% of forests
90
85
80
75
70
65
60
55
50
275
375
475
575
675
775
875
975
1075
1175
B.
85
80
75
70
65
60
55
50
650
800
950
1100
1250
1400
1550
1700
1850
Potential dense forest habitat (% of landscape)
High severity fire rotation

Loft, Eric@Wildlife

From:	Rob DiPerna <rob@wildcalifornia.org>
Sent:	Thursday, May 01, 2014 1:14 PM
To:	Wildlife Management
Subject:	Attn Neil Clipperton--EPIC status review comments--supporting documentation
Attachments:	Forsman et al 2011.pdf; BOnd et al 2002.pdf; USFWS 2009 Regulatory and Scientific Basis for FWS Guidance for Evaluation of Take for NSO 121409.pdf; Clark_2013 _NSO_Fire.pdf; ExecSummaryFinalEIS.pdf; NSO5-YrReview-R8SignedCopy10-26-2011.pdf; pnw_gtr850.pdf; franklin 2000 ecol mono.pdf; ta_spi_modifiedsurvey_nso_2013.docx

Dear Mr. Clipperton and Department Officials:

This message constitutes the first of several correspondences that will contain supporting materials for our comments to the Department for consideration as part of its CESA status review for the Northern Spotted Owl.

Please note that our comments will be delivered later today. Also please note that we will not be delivering referenced-items that we believe the Department already has access to from other sources.

Thank you for your attention. Please do not hesitate to contact me at either of the numbers provided below as necessary.

Rob DiPerna
California Forest and Wildlife Advocate
Environmental Protection Information Center
145 G Street, Suite A
Arcata, CA 95521
(707) 822-7711 Office
(707) 845-9528 Cell
www.wildcalifornia.org

Loft, Eric@Wildlife

From:	Rob DiPerna <rob@wildcalifornia.org>
Sent:	Thursday, May 01, 2014 1:32 PM
To:	Wildlife Management
Subject:	Attn: Neil Clipperton--Northern Spotted Owl EPIC comments--supporting documentation
Attachments:	20140409_2-14-022TRI_Sec5 131.pdf

Please see attached. Reference from Section V of SPI "Boomer" THP re: habitat conditions on SPI.

Thank you.

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Loft, Eric@Wildlife

From:	Rob DiPerna <rob@wildcalifornia.org>
Sent:	Thursday, May 01, 2014 4:06 PM
To:	Wildlife Management
Subject:	Attn: Neil Clipperton--Northern Spotted Owl CESA status review comments
Attachments:	dfw_statusreviewcomments_epic_5_1_14_final.pdf

Dear Mr. Clipperton and Department Officials:

Please find attached EPIC's comments regarding the Department's Northern Spotted Owl status review.

Please do not hesitate to contact me as necessary.

Thank you.

Rob DiPerna
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Loft, Eric@Wildlife

From: Rob DiPerna <rob@wildcalifornia.org>
Sent: Thursday, May 01, 2014 12:10 PM
To: Wildlife Management
Subject: Attn: Neil Clipperton--Northern Spotted Owl CESA staus review comments--group
Attachments: nso_cesa_statusreview_signon_epic_final.pdf

Dear Mr. Clipperton and Department Officials:

Please find attached a short summary comment letter that has been endorsed by numerous conservation groups.

We will be providing more extensive comments as well as supporting material later in the day today.

Thank you for your attention and consideration. Please do not hesitate to contact me at either of the numbers provided below as necessary.

Thank you.

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Loft, Eric@Wildlife

From:	Rob DiPerna <rob@wildcalifornia.org>
Sent:	Thursday, May 01, 2014 1:33 PM
To:	Wildlife Management
Subject:	Attn: Neil Clipperton--Northern Spotted Owl supporting documentation
Attachments:	2012-28714.pdf; RevisedNSORecPlan2011.pdf

Please see attached.

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Loft, Eric@Wildlife

From:	Rob DiPerna <rob@wildcalifornia.org>
Sent:	Thursday, May 01, 2014 2:40 PM
To:	Wildlife Management
Subject:	Attn: Neil Clipperton--Northern Spotted Owl supporting evidence
Attachments:	Appendix A and B_SOS_CH.pdf

Please see attached.

Thank you.

Rob DiPerna
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Environmental Protection Information Center
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(707) 845-9528 Cell
www.wildcalifornia.org

Loft, Eric@Wildlife

From: Rob DiPerna <rob@wildcalifornia.org>
Sent: Thursday, May 01, 2014 2:14 PM
To: Wildlife Management
Subject: Attn: Neil Clipperton--Northern Spotted Owl supporting materials
Attachments: GainesEtAl1997.pdf; Keane 2010 (PLS CSO 2010 Report).pdf

Please see attached.

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From: Dan Hansen [mailto:danhansen03@gmail.com]
Sent: Thursday, May 01, 2014 1:43 PM
To: Rob DiPerna
Subject: Re: Fire discussion for comment letter

Do you need all of them--even the ones that you cited in your original draft? Here are the new ones that I added (one of the three is a webinar, for which I provided a link at the bottom of the draft).

Dan

On Thu, May 1, 2014 at 1:38 PM, Rob DiPerna <rob@wildcalifornia.org> wrote:

Thanks, Dan.

If you have them, can you send me the papers that are cited here? I don't have them and really don't have time to look them up at this point.

Thanks for all your efforts! See you in June!

Rob DiPerna

California Forest and Wildlife Advocate

Environmental Protection Information Center

145 G Street, Suite A

Arcata, CA 95521

(707) 822-7711 Office

(707) 845-9528 Cell

www.wildcalifornia.org

From: Dan Hansen [mailto:danhansen03@gmail.com]
Sent: Thursday, May 01, 2014 1:34 PM
To: Rob DiPerna
Subject: Fire discussion for comment letter

Hi Rob,

Great to see you and Gary today! Here's my very quickly written version of the fire section. Feel free to use all, part, or none of it as you see fit. FYI, for the status review, we will look at quite a bit more information than is discussed here--this is just to get CDFW on the right track.

Have a great vacation!

Dan

Loft, Eric@Wildlife

From:	Rob DiPerna <rob@wildcalifornia.org>
Sent:	Thursday, May 01, 2014 12:10 PM
To:	Wildlife Management
Subject:	Attn: Neil Clipperton--Northern Spotted Owl CESA staus review comments--group
Attachments:	nso_cesa_statusreview_signon_epic_final.pdf

Dear Mr. Clipperton and Department Officials:

Please find attached a short summary comment letter that has been endorsed by numerous conservation groups.

We will be providing more extensive comments as well as supporting material later in the day today.

Thank you for your attention and consideration. Please do not hesitate to contact me at either of the numbers provided below as necessary.

Thank you.

Rob DiPerna
California Forest and Wildlife Advocate
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Arcata, CA 95521
(707) 822-7711 Office
(707) 845-9528 Cell
www.wildcalifornia.org

Sent via e-mail to: wildlifemgt@wildlife.ca.gov on date shown below

May 1, 2014

California Department of Fish and Wildlife
Nongame Wildlife Program
Attn: Neil Clipperton
1812 9th Street
Sacramento, CA 95811

Re: EPIC Comments on Department of Fish and Wildlife California Endangered Species Act Status Review for the Northern Spotted Owl (*Strix occidentalis caurina*)

Dear Mr. Clipperton and Department Officials:

The Environmental Protection Information Center (EPIC) presents the following comments on the California Department of Fish and Wildlife (CDFW or Department) status review for the Northern Spotted Owl (*Strix occidentalis caurina*) (NSO) pursuant to the California Endangered Species Act (CESA). EPIC appreciates the opportunity to provide the Department with comments and direction as it conducts its review of the status of the NSO in California.

These comments demonstrate the plight of the Northern Spotted Owl in California through the lens of an appropriate review and analysis approach that considers bio-regional differences in NSO behavior, habitat needs, prey base, and forest types. We hope that this information and approach assist the Department in developing its review which recommends listing of the NSO under CESA.

Summary

The Northern Spotted Owl warrants listing under CESA because it meets several of the criteria for listing a species as specified under the Act. Specifically, the NSO warrants listing due to the following factors: 1) past, present, and threatened habitat destruction, modification or curtailment; 2) competition from invasive species; 3) inadequate regulatory mechanisms; and 4) climate change. The preponderance of the best available evidence suggests that these and other factors are contributing to the decline of the NSO throughout all provinces in California.

I. Introduction and Background

Petition History

EPIC submitted a petition to the California Fish and Game Commission (Commission) to list the Northern Spotted Owl as either "threatened" or "endangered" under CESA on September 4th, 2012. At its August 7th, 2013 meeting, the Commission voted to accept EPIC's petition, finding that the petitioned action "may be warranted." At its December 11th, 2013 hearing the Commission adopted findings for its decision, thus initiating a one-year "candidacy" period for the NSO.

CDFW Obligations during "Candidacy" Period

Fish and Game Code section 2074.6(a) requires that within 12 months of the Commission's "candidate" designation, the Department must produce and make publicly available a final written peer-reviewed status report. This report is to be based upon the best scientific information available to the Department. The Department must evaluate whether the petitioned action is warranted, includes a preliminary identification of the habitat that may be essential to the continued existence of the species, and recommends management activities and other recommendations for recovery of the species. "Prior to releasing the final written report, the Department shall have a draft status review report prepared and independently peer reviewed, and upon receiving the peer reviewers' input, shall evaluate and respond in writing to the independent peer review and shall amend the draft status review report as appropriate." *Id*. The revised report shall be posted on the Department's Internet Web site for a minimum of 30 days for public review prior to the Commission's hearing scheduled for final consideration of the petition and listing.

Standard of Evidence

CESA is modeled on the federal ESA (FESA), and the two statutes contain very similar substantive and procedural provisions. For instance, both statutes provide for the listing and protection of threatened and endangered species in a process initiated by a citizen petition. CFGC § 2071 *et seq*., 16 U.S.C. § 1533 *et seq*. At the first step in each process, the decision makers decide whether listing "may be warranted," CFGC § 2074.2, 16 U.S.C. § 1533(b)(3)(A), and at the second step in each process, the decision makers decide whether listing "is warranted." CFGC § 2075.5, 16 U.S.C. § 1533(b)(3)(B). Under CESA, as under FESA, listing decisions must be based on the best available science. CFGC §§ 2072.3, 2074.6; 16 U.S.C. § 1533(b)(1)(A).

California courts have explained that "it is a basic premise of statutory construction that when a state law is patterned after a federal law, the two are construed together." *NRDC v. California Fish & Game Comm.*, 28 Cal.App.4th 1102, 1118 (1994), citing *Moreland v. Department of Corporations*, 194 Cal.App.3d 506, 512-13 (1987). Thus, interpretation of the federal ESA guides CESA. This is particularly applicable here, as case law has determined that scientific certainty is not required for a species to qualify for protected status through listing.

> The [FESA] contains no requirement that the evidence be conclusive in order for a species to be listed. Application of such a stringent standard violates the plain terms of the statute . . . Congress repeatedly explained that it intended to require the FWS to take preventive measures before a species is ‘conclusively’ headed for extinction. The purpose of creating a separate designation for species which are ‘threatened’, in addition to species which are ‘endangered’, was to try to ‘regulate these animals before the danger becomes imminent while long-range action is begun.’
>
> The FWS itself has taken the position that it need not, and must not wait for conclusive evidence in order to list a species. For example, in its decision to list the northern spotted owl, it explained that because the agency had ‘used the best data available to prepare the proposed rule, it was ‘not obligated to have data on all aspects of a species biology prior to reaching a determination on listing’. Moreover, the agency concluded that ‘to withdraw the proposal and conduct additional research would not improve the status of the [species] and would not be in keeping with the mandates of the Endangered Species Act.’ More recently, the FWS decided to list the California red-legged frog, even though many aspects of the species’ status were ‘not completely understood’, because ‘a significant delay in listing a species due to large, long-term biological or ecological research efforts could compromise the survival of the [species].’
>
> Furthermore, Defendants have gone to great lengths to argue that there is a lack of ‘scientific certainty’ as to various aspects of the [species’] status. The ESA does not, however, require such ‘certainty’ to justify the listing of a species. To the contrary, the clear intent and purpose of Congress in enacting the ESA was to provide preventive protection for species before there is ‘conclusive’ evidence that they have become extinct.

Defenders of Wildlife v. Babbitt, 958 F.Supp. 670, 679-81 (D.D.C. 1997) (internal citations omitted).

Accordingly, the Department cannot dismiss the need for listing of the NSO based on a claim of lack of “scientific certainty.” Rather, following the U.S. Fish and Wildlife Service’s (FWS) lead, the Department should determine whether or not listing is warranted based on the preponderance of available evidence. Like any topic of scientific research, there is scientific uncertainty regarding the status and ecology of NSOs. Nonetheless, the NSO is one of the most thoroughly studied vertebrates in North America and a substantial and compelling body of scientific information about the species is currently available.

Recommended Review Approach

EPIC strongly believes that any approach to conducting a status review for the NSO must be firmly rooted in the species’ ecology. As noted by the FWS and leading researchers, the NSO’s ecology, status, and threats vary among regions, forest types, and elevation zones (USFWS 2011, 2012; Forsman et al. 2011; Courtney et al. 2004). Any robust status review must also consider the available information on NSO populations, trends, and threats across ownership classes, and indeed down to the individual ownership level. Finally, care must be taken in how the Department weighs the various types and sources of information it receives for consideration. For example, the Department clearly must give greater weight and consideration to long-term peer-reviewed studies related to the NSO in California over unpublished, non-peer-reviewed monitoring reports or raw data from project-level surveys.

II. Status of the Northern Spotted Owl

Range-wide Trends

Forsman et al. (2011) identifies three categories of study to determine NSO trends range-wide. These are fecundity, apparent survival, and population trends. Below is a summary of the findings of Forsman et al. (2011) with respect to study areas range-wide.

TABLE 1: Summary of trends in demographic parameters for northern spotted owls, from 11 study areas 1985-2008, adapted from Forsman et al. (2011).

Study Area	Fecundity	Apparent survival	Population trend
Washington			
Cle Elum	Declining	Declining	Declining
Rainier	Increasing	Declining	Declining
Olympic	Stable	Declining	Declining
Oregon			
Coast Range	Increasing	Declining since 1998	Declining
H.J. Andrews	Increasing	Declining since 1997	Declining
Tyee	Stable	Declining since 2000	Stationary
Klamath	Declining	Stable	Stationary
Southern Cascades	Declining	Declining since 2000	Stationary
California			
Northwestern California	Declining	Declining	Declining
Hoopa	Stable	Declining since 2004	Stationary
Green Diamond	Declining	Declining	Declining

California Trends

A primary purpose of the status review is to determine trends in Northern Spotted Owl abundance, population, distribution, and demographic rates for California. EPIC recommends that the Department conduct its review on a bio-regional level, and at landscape and individual ownership scales. We address some of these factors below.

Range and Distribution

As noted in the petition, historically, the Northern Spotted Owl was found from British Columbia through western Washington, western Oregon, and northwestern California from Siskiyou County south to Marin County (American Ornithological Union 1957, Forsman 1976, Forsman et al. 1984, Gutiérrez et al. 1995). The ranges of the Northern and California subspecies of spotted owls meet at the southern end of the Cascade Range, near the Pit River area in northern California. In California, populations are declining in two of three long-term monitoring sites while numerous historic territories have been lost from interior forests in California. The Revised Recovery Plan for the Northern Spotted Owl states: “Many historical spotted owl site-centers are no longer occupied because spotted owls have been displaced by barred owls, timber harvest, or fires” (U.S. Fish and Wildlife Service 2011) (Petition, at page 7).

Despite this, the Department’s initial petition evaluation (CDFW 2013) states that,

> “Based on information in the Petition and other data that is readily available to the Department for California, there is not evidence to indicate that the distribution of northern spotted owl has changed during the time period of years for which surveying/monitoring of the species distribution has occurred” (CDFW Petition Evaluation, at 6).

While further study is needed to determine the range and distribution of the NSO range-wide and within California, the Department cannot reject listing based on an erroneous standard of “certainty” in the evidence; it must consider the best evidence available at the time of its status review, which instructs that the NSO population is declining in California.

NSO Abundance

With respect to NSO abundance, the Fish and Game Commission’s finding, citing the Department’s petition evaluation determined the following:

> “The petition (pages 12-15) does not include direct information about the population size or abundance of NSO populations in California, nor does it discuss abundance range-wide. The Department deemed the relevant information found in the literature cited in the petition and other scientific documents consulted for its evaluation report to be inconclusive to determine the abundance of NSO range-wide or in California, and concluded that further research and analysis is required to determine the abundance for NSO populations in California. (Evaluation Report, page 6).”

Further study is needed to answer the question of NSO abundance in California. In its initial petition evaluation the Department referenced the NSO database maintained as part of the California Native Diversity Database (CNDDB), and acknowledged that until recently this database has not been regularly maintained (CDFW Petition Evaluation, at page 3). The NSO CNDDB may be a useful tool for estimating owl abundance in California, but its utility is clearly limited. Not only is the database limited by infrequent maintenance, but it is also limited in use due to inadequate survey coverage in many areas.

While the evidence available to the Department regarding the abundance of NSO is inconclusive, there is clear evidence of negative demographic trends in California and rangewide (Forsman et al. 2011). Occupancy rates from Timber Company monitoring reports (e.g., CDFW 2013 errata sheet, page 1) should be considered as part of the body of information available concerning the

NSO's status in California (see below). However, they do not represent an equally rigorous or valid counterweight to peer-reviewed, long-term demographic research.

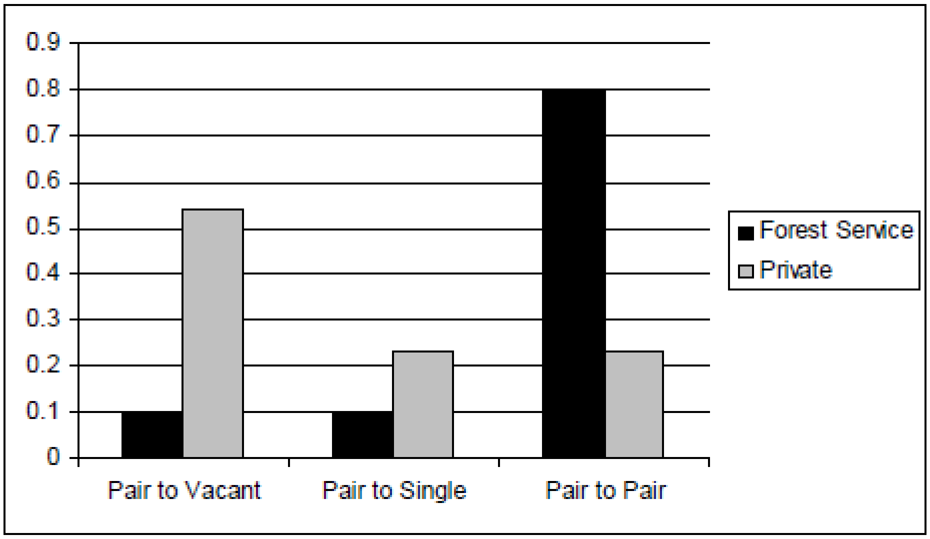
Occupancy trends

The Yreka office of the FWS has completed an extensive analysis of the status of historical spotted owl activity centers on federal and private lands in interior northern California (U.S. Fish and Wildlife Service 2009). The FWS found that extensive losses of owl pairs occurred on private lands, which sharply contrasted with the persistence of owl pairs on federal lands. (U.S. Fish and Wildlife Service 2009: 11-12) stated:

> To quantify the pattern of territory loss identified during the technical assistance process, we compared results of protocol surveys conducted at verified NSO territories supporting at least one year of occupancy by paired owls on Forest Service lands (N=196) with similar data from private timberlands (N=75) in Shasta and Trinity counties. The data set consisted of activity center status records in the California Department of Fish and Game's Spotted Owl Database (CDFG-NSO database), supplemented with territory locations and recent survey records received during technical assistance. We first evaluated the validity of activity center records in the CDFG-NSO database, and eliminated 18 sites on private lands due to lack of verification of status. The remaining 57 private-land activity centers had verified NSO status in at least one year between 1989 and 2007; 44 of these sites had supported pairs during at least one year. Of these verified pair sites, 54% declined from pair status to no response, and an additional 23% declined from pair status to a territorial single owl during subsequent protocol surveys (Figure I.B.1). On Forest Service-administered lands, 80% of pair sites did not change status during the same time periods. While we recognize that annual variation in survey effort and results at this relatively coarse scale of resolution may influence this type of analysis, the strong differences in trends observed on private versus federal lands supports the contention that management on private timberlands is creating habitat conditions that do not support sustained occupancy by NSO" (U.S. Fish and Wildlife Service 2009: 11-12).

The FWS created the figure below to illustrate the results of their analysis.

Figure I.B.1. Status of valid historical northern spotted owl activity centers (pair sites only) when resurveyed after 5-10 years. Data are from U.S. Fish and Wildlife Service technical assistance records and USFS monitoring records



This and other available evidence suggests that NSO site occupancy on private forestlands in interior California is declining.

III. Immediacy of Threats to the Northern Spotted Owl

Past, Present, and Threatened Habitat Destruction, Modification, or Curtailment

The topic of habitat loss must be broken into several categories to address the myriad of factors influencing past, present, and threatened habitat destruction, modification, or curtailment within the species range and in California specifically. We address the following factors affecting NSO habitat loss, modification, and curtailment: 1) timber harvest on public and private lands; 2) stand-replacing fire; and 3) habitat conversion.

Timber Harvest

The 2011 Revised Recovery Plan for the Northern Spotted Owl (U.S. Fish and Wildlife Service 2011) identifies past and present habitat loss due to timber harvest as a primary threat to the species range-wide. After a status review (U.S. Fish and Wildlife Service 1990a), the spotted owl was listed under the Endangered Species Act (ESA) as threatened on June 26, 1990 (U.S. Fish and Wildlife Service 1990b) because of widespread loss of the species' habitat across the spotted owl's range and the inadequacy of existing regulatory mechanisms to conserve the spotted owl. Past habitat loss and current habitat loss are also threats to the spotted owl, even though loss of habitat due to timber harvest has been greatly reduced on Federal lands over the past two decades (U.S. Fish and Wildlife Service 2011). The impacts of ongoing and threatened habitat loss, disturbance, and modification are significant and constitute a fundamental reason for listing.

The 2011 Revised Recovery Plan identified the impacts of timber harvest as a main threat to the NSO.

> "Currently, the most important range-wide threats to the spotted owl are 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" (U.S. Fish and Wildlife Service 2011).

Data presented in the 2011 Revised NSO Recovery Plan clearly shows substantially higher levels of NSO habitat loss on non-federal versus federal lands since the advent of the Northwest Forest Plan. Table 2-B taken from the Recovery Plan (below) indicates that non federal lands logging in California accounted for 5.8 percent of total habitat lost in California. Range-wide, 14.9% of NSO habitat on private lands within the range of the owl has been lost between 1994/96-2006/2007 to logging. Table B-2 demonstrates that habitat loss, modification, and curtailment continue to occur on both public and private lands in California and range-wide.

Table B-2. Estimated amount of spotted owl nesting and roosting habitat1 at the start of the Northwest Forest Plan (baseline 1994/96[2]) and losses owing to harvest through 2006/7[2], by State and ownership (adapted from Davis and Dugger in press).

Land class	Baseline (1994/96[2])	Harvest	Total Percent loss[3]
Federal reserved			
Washington	2,274,200	7,900	0.3%
Oregon	2,699,600	6,100	0.2%
California	1,214,000	2,500	0.2%
Range-wide total	6,187,800	16,500	0.3%
Federal non-reserved			
Washington	470,200	4,800	1.0%
Oregon	1,561,400	23,800	1.5%
California	634,400	8,700	1.4%
Range-wide total	2,666,000	37,300	1.4%
Non-federal			
Washington	1,258,900	234,200	18.6%
Oregon	1,382,400	301,200	21.8%
California	1,556,700	90,200	5.8%
Range-wide total	4,198,000	625,600	14.9%
Range-wide total	13,052,000	679,400	5.2%

[1] See Davis and Dugger (in press) for description of habitat.
[2] 1996 and 2006 for Oregon and Washington, 1994 and 2007 for California.
[3] Loss is the term used in Davis and Dugger (in press) to describe their data, which is summarized here.

On public lands, federal land management poses many problems for spotted owls. All federal lands within the range of the NSO are currently managed under the provisions of the Northwest Forest Plan (NWFP). The NWFP was adopted in 1994, and it amended land management planning documents for 19 National Forests and seven Bureau of Land Management districts throughout Washington, Oregon and California. The NWFP established a late-successional reserve (LSR) network and specified management standards and guidelines to further the recovery of the NSO.

The 15-year report on the NWFP performance for spotted owls was recently released. It shows that the NWFP is simply not adequate to ensure recovery of the species (Davis et al. 2011). The NWFP was based on overly optimistic assessments of spotted owl demographic performance (Franklin et al. 1999, Anthony et al. 2006). Demographic studies (Franklin et al. 1999, Anthony et al. 2006, Forsman et al. 2011, Davis et al. 2011) have demonstrated that the population declines are at a much greater rate than was anticipated across their range and particularly in Washington. In light of this decline, Forsman et al. (2011) stressed the importance of retaining high quality owl habitat: "[i]n view of the continued decline of Spotted Owls in most study areas, it would be wise to preserve as much high quality habitat (i.e., late-successional forests) for Spotted Owls as possible, distributed over as large an area as possible."

It is much more difficult to quantify habitat loss, modification, and/or curtailment resulting from timber harvest on private lands than it is on public lands. Currently, there are no entity tracking habitat loss and modification, and there is no data, studies, or other information that addresses the impacts of timber harvest and other forest management practices on the NSO on private lands in California.

In our petition to the Fish and Game Commission, EPIC attempted to quantify habitat loss across some ownerships in California to illustrate that current and threatened habitat loss, modification and/or curtailment was continuing on private lands. In its initial petition evaluation, the Department was critical of our approach, citing inconsistencies in the numbers of acres of habitat removed versus the total acres of specified Timber Harvest Plans (THPs) (CDFW Petition Evaluation, at pages 10-11).

Because there is currently no entity in the State of California tracking the amount of NSO habitat lost, modified, or curtailed as a result of timber harvest activities on private lands, the best available source of information regarding these factors is contained may be individual THPs. We understand and appreciate the limitations of quantifying NSO habitat loss, modification, and/or curtailment by simply analyzing individual THPs. Indeed, information pertaining to the true impacts of timber operations on the NSO provided in THPs is often insufficient to allow for meaningful review of potentially significant impacts. The lack of accountability for habitat loss as a result of timber harvest is another reason why existing regulatory mechanisms are inadequate, and are another reason why listing under CESA is warranted. (See below).

What information is available documents that timber harvest activities in California are in fact destroying, modifying, or curtailing NSO habitat on private lands, and that the cumulative effect of over 150 years of such activities has left the NSO with a landscape that is largely either unsuitable or of very low quality to support stable or increasing rates of NSO occupancy, reproduction and survival.

The FWS's 2009 NSO "take" avoidance guidelines document (U.S. Fish and Wildlife Service 2009) provides the following conclusion regarding the impacts of persistent timber harvest on NSO habitat conditions on private lands:

> "…the strong differences in trends observed on private versus federal lands supports the contention that management on private timberlands is creating habitat conditions that do not support sustained occupancy by NSO." (p 12).

Indeed, in its March 29, 2013 letter of Technical Assistance to CAL FIRE and Sierra Pacific Industries (SPI) (TA 08YRE00-2013-007) the FWS made the following observation about habitat conditions on SPI lands:

> "[The U.S. Fish and Wildlife Service] have determined that SPI's landscape is dominated by habitats considered to provide foraging and quality foraging habitat. Suitable nesting/roosting habitat on SPI managed lands is much more limited." (U.S. Fish and Wildlife Service 2013).

SPI further acknowledges that its lands do not contain any high-quality nesting/roosting habitat in its own THPs, stating:

> "The absence of high quality nesting roosting habitat is largely a result of the USFWS's robust definition of this habitat type that exceeds the habitat conditions of most stands, except those that would traditionally be called "old growth" or primary older forest where no management footprint exists. These stands are not common in areas where historic or past management has been engaged either by Government or private land managers." (SPI THP 2-14-022TRI "Boomer" THP, Section V, page 293).

There are little, if any "primary older forests," or "old growth" forest habitat types available on SPI lands. SPI acknowledges that past management has resulted in the near extirpation of "primary older forests" or "old growth forests" on its property. *Id*. These forest types are clearly identified as preferable habitats for the NSO. As identified in the petition, the best available science shows that relatively large areas of structurally complex, older forests provide the habitat necessary to support viable populations of Northern Spotted Owls (Forsman et al. 2011). Spotted owls generally rely on older forested habitats because such forests contain the structures and characteristics required for nesting, roosting, and foraging, and dispersal.

Past, present and threatened habitat loss due to timber harvest remains a substantial threat to the Northern Spotted Owl in California. Habitat loss is ongoing on both public and private lands, and inadequate regulatory mechanisms exist to curtail this threat. (Please refer to section on inadequacy of regulatory mechanisms below).

Wildfire and Post-Fire Salvage Logging

Two major lines of evidence are available for evaluating effects of wildfire on NSOs: estimated loss of suitable habitat on federal lands (Davis and Dugger 2011) and studies of direct effects of fire on NSO demography, occupancy, and behavior (Bond et al. 2002, Clark et al. 2011, 2013).

Davis and Dugger (2011) estimated losses of suitable nesting-roosting habitat to wildfires and other disturbances on federal lands during 1994/1996 to 2006/2007 (evaluation periods varied among physiographic provinces). During that period some provinces experienced substantial (up to 10.2%) losses of suitable nesting-roosting habitat (Table B-1 [from the 2011 Recovery Plan, Figure 3-12 from Davis and Dugger 2011). These losses were primarily due to large wildfires in dry forests; largely within the Oregon and California Klamath provinces. Wildfires also fragmented suitable nesting-roosting habitat during this period (Figure 3-18 from Davis and Dugger 2011). Loss of 'core' (non-edge) nesting-roosting habitat could negatively affect NSO populations, due to the relationship between NSO fitness and amounts of core old-forest centered on nest trees or activity centers (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005).

Table B-1. Spotted owl habitat loss on Federal lands resulting from harvest and natural disturbances from 1994/96[1] to 2006-7[1] (acres) (adapted from Davis and Dugger in press).

Physiographic Provinces	1994/96 acres	Harvest (%)[2]	Natural Disturbance			Total Habitat Loss	Total Percent loss[2,3]
			Wildfire	Insects and disease	Total (%)[2]		
Olympic Peninsula	763,100	**500** *(0.06%)*	200	0	**200** *(0.03%)*	700	**0.1%**
Eastern WA Cascades	673,600	**8,100** *(1.2%)*	20,000	2,000	**22,000** *(3.3%)*	30,100	**4.5%**
Western WA Cascades	1,283,000	**3,700** (0.3%)	700	400	**1,100** (0.09%)	4,800	**0.4%**
Western WA Lowlands	24,700	**400** *(1.6%)*	0	0	**0**	400	**1.6%**
OR Coast Range	611,200	**3,300** *(0.5%)*	0	0	**0**	3,300	**0.5%**
OR Klamath	985,000	**6,800** *(0.7%)*	93,600	300	**93,900** *(9.5%)*	100,700	**10.2%**
Eastern OR Cascades	402,900	**5,800** *(1.4%)*	17,800	2,300	**20,100** *(5.0%)*	25,900	**6.4%**
Western OR Cascades	2,258,700	**13,900** *(0.6%)*	28,900	1,100	**30,000** *(1.3%)*	43,900	**1.9%**
Willamette Valley	3,400	**100** *(2.9%)*	0	0	**0**	100	**2.9%**
CA Coast	145,400	**300** *(0.2%)*	2,100	100	**2,200** *(1.5%)*	2,500	**1.7%**
CA Cascades	213,200	**6,500** *(3.0%)*	1,800	300	**2,100** *(1.0%)*	8,600	**4.0%**
CA Klamath	1,489,800	**4,400** *(0.3%)*	71,600	1,600	**73,200** *(4.9%)*	77,600	**5.2%**
Range-wide total	8,853,000	**53,800** *(0.6%)*	236,700	8,100	**244,800** *(2.8%)*	298,600	**3.4%**

[1] 1996 and 2006 for Oregon and Washington, 1994 and 2007 for California.
[2] Percent of 1994/96 habitat.
[3] Loss is the term used in Davis and Dugger (in press) to describe their data, which is summarized here.

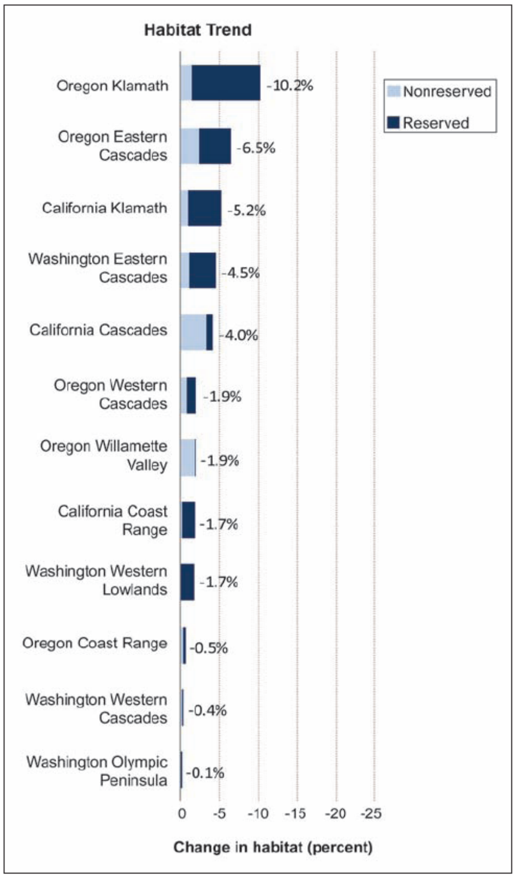


Figure 3-12—Nesting/roosting habitat trends (based on the LandTredr analysis) from 1994/96 to 2006/07 by physiographic province for reserved and nonreserved federal lands.

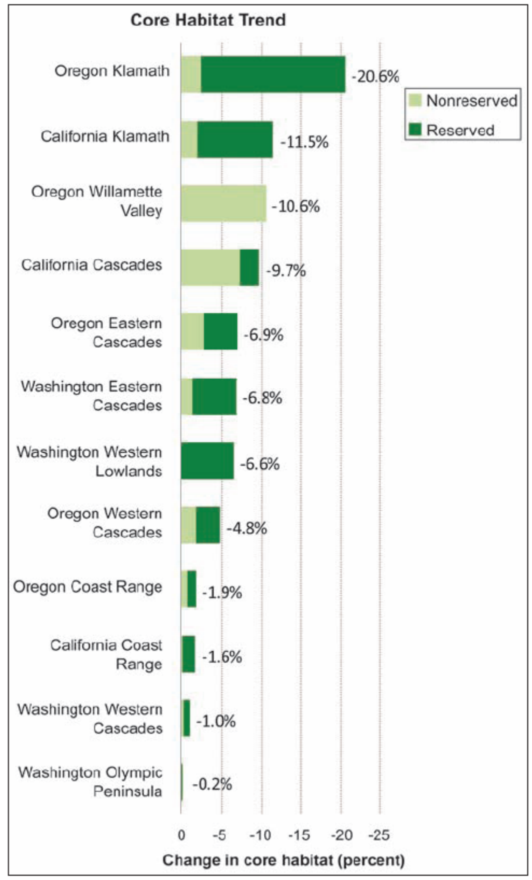


Figure 3-18—Nesting/roosting "core" habitat trends from 1994/96 to 2006/07 by physiographic province for reserved and nonreserved federal lands.

Bond et al. (2002) measured short-term (1 year) survival of 21 spotted owls and productivity of 7 pairs in 11 recently burned territories (4 NSO, 3 California spotted owl, and 4 Mexican spotted owl). Fire burned 83-100% of the area within estimated territories, including known nest and roost areas. Fire severity was mapped for 8 of 11 territories: 6 of these primarily experienced low- to moderate-severity fire and two experience extensive severe fire. The authors re-sighted 18 of 21 (86%) individual owls after the fires and 16 of these (89%) were in their pre-fire territories. These estimate survival and territory fidelity rates are similar to those found in other, longer-term studies of the three spotted owl subspecies. Bond et al. (2002) found 7 pairs in burned areas 1-year post-fire and an average of 1 offspring produced per pair. This level of productivity was higher than those found in other studies. While based on very small sample sizes, this study suggests that, in the very short-term (1-year post-fire) spotted owls may often continue to occupy and breed within territories that have experienced fire; particularly low-to-moderate severity fire.

Clark et al. (2013) examined how fire and subsequent salvage logging affected occupancy dynamics of NSOs in two wildfire areas in southwestern Oregon. First, the authors compared occupancy dynamics before and after the Timbered Rock Fire to those in another area not recently burned by wildfire (South Cascades study area). The burned study area (Timbered Rock) experienced a 64% reduction in site occupancy post-fire, compared with a 25% reduction in the unburned study area (South Cascades) during the same period. These results suggest that wildfire and/or post-fire salvage logging negatively affected site occupancy by NSOs. In the study's second analysis, the authors examined possible relationships between NSO occupancy dynamics and wildfire, post-fire salvage logging, and other habitat conditions in three burned areas (Biscuit, Timbered Rock, and Quartz). They were unable to determine relationships between pre-fire occupancy dynamics and habitat variables but they did find that site occupancy declined in the short-term post-fire. Declines in occupancy did not appear to have been due to salvage logging alone since post-fire site extinction probabilities were highest in the Biscuit Fire study area, in which 13.6% and 17.1% of intermediate-age and older forests experienced moderate and high severity fire, respectively, compared with only 1.6% being salvage logged. Past timber harvesting, high-severity fire, and post-fire salvage logging likely cumulatively contributed to declines in site occupancy in all three burned areas.

In the same study, Clark et al. (2011) estimated annual survival rates for 23 territorial NSOs in three burned study areas (Quartz, Timbered Rock, Biscuit). The remains of 4 of the 5 dead NSOs recovered during the study were severely emaciated, suggesting that the owls died of starvation; possibly due to wildfire and/or salvage logging effects on foraging habitat or prey populations. Estimated annual survival rates for owls located inside the fire perimeters or displaced by the fires and/or post-fire salvage logging were lower than those both in areas just outside the fire perimeters and in an unburned reference study area (South Cascades).

Apparently contradictory results found by these studies may be due to several factors, in addition to the occurrence of salvage logging in one study and not the other. For example, spotted owl populations in the areas studied by Clark et al. (2011) may have been more sensitive to habitat changes than those studied by Bond et al. (2002) because suitable nesting-roosting habitat was more limited due to past intensive timber harvesting and a checkerboard ownership pattern. It is also possible that the study by Bond et al. (2002) was too short to detect a negative effect of wildfire on spotted owls. For example, mortality of trees due to insect attack can take more than a year to occur (Gaines et al. 1997). Furthermore, spotted owls may not immediately respond to habitat changes due to strong fidelity to territories and mates. It is also likely that the studies' discrepant findings were strongly influenced by differences in fire severity. Much of the area studied by Clark et al. (2011) was severely burned and/or salvage logged (approximately 30-40%), while the majority of territories studied by Bond et al. (2002) primarily experienced low- to moderate-severity fire and none were salvage logged. Studies of California and Mexican spotted owls generally support conclusions that large, severe fires can have strong negative effects on spotted owls, whereas the species appears to be resilient to low- to moderate-severity fires (e.g., Keane et al. 2010, 2012).

Land use and Habitat Conversion

Conversion of Northern Spotted Owl habitat to other land uses was not identified as a significant threat to the species in the Revised Recovery Plan. There is, however an emerging and as yet little-understood threat in California—land conversion for cannabis agriculture, both legal and illegal. While there is little actual quantifiable evidence to demonstrate the extent or severity of this threat, it is clear that conversion of forests to agricultural cannabis use, both legal and illegal can fragment and degrade habitat for the NSO. NSO may also be affected when riparian areas are altered due to water diversion for cannabis agriculture.

Competition from Invasive Species

Competition from non-native invasive species has emerged as one of the greatest threats to NSO conservation. The larger and more aggressive barred owl (*Strix varina*) has made its way from eastern North America to the Pacific Northwest, and now into California. According to the Executive Summary for the Final EIS for experimental barred owl removal, the range of the barred owl now completely overlaps with that of the Northern Spotted Owl (U.S. Fish and Wildlife Service 2013).

The FEIS Executive Summary notes that:

> "Although northern spotted owl populations have been declining for many years, the presence of barred owls exacerbates the decline. Recent studies (Olson *et al*. 2005, p. 918; Forsman *et al*. 2011a, pp. 69-70, 75-76) have established negative relationships between barred owl presence and declines in spotted owl population performance across the range of the subspecies. This could result in the extirpation (local extinction) or near extirpation of the northern spotted owl from a substantial portion of their historical range, even if other known threats, such as habitat loss, continue to be addressed." (U.S. Fish and Wildlife Service 2013).

The 2011Revised Recovery Plan summarizes the general findings of the latest science regarding the effects of barred owls on Northern Spotted Owls.

> "Barred owls reportedly have reduced spotted owl site occupancy, reproduction, and survival. Limited experimental evidence, correlational studies, and copious anecdotal information all strongly suggest barred owls compete with spotted owls for nesting sites, roosting sites, and food, and possibly predate spotted owls…. Because the abundance of barred owls continues to increase, the effectiveness in addressing this threat depends on action as soon as possible." (U.S. Fish and Wildlife Service 2011, p. III-62).

Dugger et al. 2011 further summarizes the affects of barred owls on NSO and provides clear recommendations to protect as much habitat as possible to mitigate these effects:

> "We observed increased extinction rates in response to decreased amounts of old forest at the territory core and higher colonization rates when old-forest habitat was less fragmented. Annual site occupancy for pairs reflected the strong effects of Barred Owls on occupancy dynamics with much lower occupancy rates predicted for territories where Barred Owls were detected. The strong Barred Owl and habitat effects on occupancy dynamics of Spotted Owls provided evidence of interference competition between the species. These effects increase the importance of conserving large amounts of contiguous, old-forest habitat to maintain Northern Spotted Owls in the landscape." (Dugger et al. 2011).

The implications for this invasive competition on the Northern Spotted Owl are clear and enormous. Listing of the Northern Spotted Owl under CESA is warranted for this reason alone, not withstanding all the other well-documented threats to the species.

Inadequate Regulatory Mechanisms

The petition at Section D-pages 19-23 describes the inadequacy of regulatory mechanisms range-wide and in California, on both public and private lands. We further discuss the inadequacy of regulatory mechanisms on public and private lands in California.

Public Lands

Federal land management poses many problems for Northern Spotted Owls. All federal lands within the range of the Northern Spotted Owl are currently managed under the provisions of the NWFP. As noted above, the NWFP alone is inadequate to provide recovery for the NSO, and populations are still in decline. (Davis et al. 2011, Franklin et al. 1999, Anthony et all 2006, Forsman et al. 2011).

According to Appendix A of the U.S. Fish and Wildlife Service's consultation for the U.S. Forest Service's Gemmill Thin project, the FWS has provided consultation on U.S. Forest Service Timber Sales within the range of the Northern Spotted Owl since 1994. Between 1994 and October 24, 2013, the FWS has consulted on the proposed removal/downgrade of approximately 708,155 acres (Table A1), or eight percent of the 8.854 million acres of Northern Spotted Owl nesting/roosting habitat estimated by Davis et al. (2011) to have occurred on Federal lands (Table A1). While these changes in suitable Northern Spotted Owl habitat may be consistent with the expectations for implementation of the NWFP, which anticipated a rate of habitat harvested at 2.5 percent per decade on public lands (USFS and BLM 1994a) (U.S. Fish and Wildlife Service 2013), they nonetheless document that habitat loss, modification, and/or curtailment are occurring on public lands, and that the NWFP has not adequately curtailed such habitat modification.

In all, the available evidence suggests that while the NWFP has reduced logging of suitable habitat on public lands, habitat loss and degradation is still occurring, including within the so-called "late-successional reserves." The inadequacies of the NWFP to protect spotted owls and preserve the species habitat constitute a substantial threat to the NSO.

Private Lands

The California Forest Practices Rules (FPRs) are the primary state regulations affecting the management of the Northern Spotted Owl on private lands in California. These regulations implement the Z'berg Nejedley Forest Practices Act of 1973 (Pub. Res. Code § 4511 et seq.).

The FPRs provide a suite of options for landowners to achieve the goal of "take" avoidance (14 CCR 919.9[939.9]). These options (a-g) were adopted by the California Board of Forestry and Fire Protection (Board of Forestry) in the early 1990's in response to the federal listing of the NSO as a "threatened" species under the federal ESA.

In addition to 14 CCR 919.9 [939.9] the FPRs also contain specific criteria to guide CAL FIRE in making a determination that “take” has been avoided (14 CCR 919.10 [939.10]). The FPRs provide that if CAL FIRE determines that “take” will not be avoided, then the Director must disapprove the plan (14 CCR 989.2 (f)).

When the NSO was originally listed, the then-California Department of Fish and Game provided consultation services to landowners and the California Department of Forestry and Fire Protection (CAL FIRE) on individual Timber Harvest Plans (THPs) in hopes of ensuring that “take” would be avoided. The Department of Fish and Game turned the biological review of individual projects to the FWS in 1999. Since that time the CDFW has been largely absent from the review and approval process for individual projects that may impact the NSO. The FWS conducted a process known as “technical assistance” whereby it reviewed individual THPs to ensure “take” avoidance through the lens of the existing FPRs, while augmenting its review with independent agency biological expertise. Although the process of seeking technical assistance falls under 14 CCR 919.9(e) [939.9(e)], the actual criteria for habitat protection and retention standards are contained in 14 CCR 919.9(g) [939.9(g)]. The FWS provided technical assistance through the lens of 14 CCR 919.9(g) [939.9(g)].

In 2009, the FWS ceased providing technical assistance to landowners and CAL FIRE. CAL FIRE thus became solely responsible for ensuring “take” avoidance. In doing so, the Service provided CAL FIRE with a review of the effectiveness of the FPRs to avoid “take” of NSO as defined under the federal Act. The FWS also provided CAL FIRE with a set of alternative “take” avoidance guidelines it believes would be more effective at protecting the NSO than current Rules.

The FWS’s guidance document specifically called out the ineffectiveness of existing FPRs. The FWS’s overall conclusion was:

> “…our combined experience with hundreds of THPs indicates that **the cumulative effects of repeated entries within many NSO home ranges has reduced habitat quality to a degree causing reduced occupancy rates and frequent site abandonment**. In a large proportion of technical assistance letters to CAL FIRE and industrial timberland owners during the past five years, we noted the lack of NSO responses at historic territories, and described habitat conditions considered inadequate to support continued occupancy and reproduction.” (Emphasis added) (p 11).

14 CCR 919.9(g)[939.9(g)] otherwise known as “option “g”” contains prescriptive rules that delineate how much total NSO habitat must be retained following a given timber harvest in order to ensure that “take” is avoided. Habitat has traditionally been described using the definitions found in the FPRs at 14 CCR 895.1. Option “g” does not specify quantities of individual habitat types to be retained and in what configuration. Option “g” also contains disturbance minimization measures that are primarily employed during the breeding season for the NSO.

CAL FIRE advised the Board of Forestry at its March 2013 hearing that option "g"" is out-of-date, and no longer reflects the best available science.

> "…the Department recognizes that frankly Ken [Hoffman] knows we have been working with him prior to retirement in the Service and we have recognized the problems with option "g" for quite some time and even before we were handed the full brunt of the responsibility back in 2008 we had heard from the Service that option "g" was really not adequate." (Shintaku 2013).

Mr. Shintaku agreed with points made at the hearing by EPIC that option "g" is obsolete and inadequate:

> "…so first of all CAL FIRE agrees with EPIC in terms of the obsolete nature of option "g".... so really where we are today is what we are calling "g-plus".... what that means is we recognize "g" is not going to get it done, but the rules specifically say an RPF only has the choices "a"-"g" in order to address a spotted owl in a THP, so because the RPF has to say I am using option "g," coupled with the fact that we know option "g" is obsolete that forces the Department into what I would consider a full-blown CEQA analysis; we have to make sure that significant impacts, cumulative impacts and take are all addressed in the plan, and we just use the "g" vehicle to get that done." (Shintaku 2013).

The U.S. Fish and Wildlife Service (2009) identified several failings in the standard provisions and application of option "g." These include inadequate habitat retention standards and out dated habitat definitions. Regarding the existing FPR Northern Spotted Owl habitat definitions contained at 14 CCR 895.1 the Service stated:

> "...use of [California] W[ildlife] H[abitat] Relationship[s] habitat definitions in the FPRs is unlikely to avoid take. This is because the WHR types considered to be NSO habitat (4M & 4D) are widely variable, and at the lowest end of size class/density are typically poor habitat or non-habitat." (1-24-08 e-mail from Brian Woodbridge to CAL FIRE's Chris Browder).

The FWS expounded on the inadequacies of the FPR definitions:

> "Service staff in the Yreka Fish and Wildlife Office believe that application of the FPRs **typically does not avoid or reduce the likelihood of take of NSO**. This is because the habitat definitions and retention standards in the FPRs represent minimum values that are below the habitat parameters associated with reasonable levels of territory occupancy, survival, and reproduction by NSO."(ibid)(Emphasis added).

The following tables summarize the differences between the FPR NSO habitat definitions and the definitions recommended by the FWS:

FWS Interior				
	Basal Area	**TPA 26"+**	**Canopy closure**	**QMD (DBH)**
HQNR	210	> 8	>60%	>15"
N/R	150-180	>8	>60%	>15"
F	Mix ranging 120-180	>5	Mix 40-100%	>13"
LQF	Mix ranging 80-120		>40%	>11"

Forest Practice Rules		
	Canopy closure	**DBH**
N	>60% total (40% dominant and co-dominant)	>11"
R	>40% with high degree of variability	>11"
F	>40% but if more than 80% must be "fly space"	>11" conifer >6" hardwoods

As noted by CAL FIRE's Duane Shintaku, CAL FIRE has recognized the ineffectiveness of option-"g" and has begun to undertake a heretofore undefined review and approval process for THPs utilizing option "g" known only as "g-plus." CAL FIRE is implementing a review and approval process for THPs utilizing option "g" or "g-plus" that has not been vetted by a rulemaking process and that is not specified in regulation. This is contrary to the requirements of the FPRs themselves. 14 CCR 898.1 provides that the provisions of the Forest Practice Act and the FPRs shall be the only criteria employed by the Director when reviewing plans, consistent with Public Resources Code section 4582.7. CAL FIRE is left in the precarious position of recommending that landowners comply with the FWS Guidelines while not being able to require their implementation due to the lack of codified regulations to address the inadequacies of the existing Rules.

The existing evidence provided by the FWS indicates that existing regulatory mechanisms, particularly on private lands, are inadequate and have failed to curtail the downward trend of NSO fecundity, apparent survival, and populations in California. Listing of the NSO under CESA is necessary because the existing regulatory mechanisms are inadequate and because the lack of independent agency biological expertise of the CDFW and the FWS has resulted in CAL FIRE in the precarious position of determining that "take" has been avoided without consultation with the listing agency.

<u>Climate Change</u>

The Revised Recovery Plan acknowledged that climate change has been and will continue to affect forest ecosystems in the range of the Northern Spotted Owl. In preparing the recovery plan, the experts identified disease and the effect of climate change on vegetation as potential and more uncertain future threats. (U.S. Fish and Wildlife Service 2011, at I-8)

Franklin et al. 2000 found that changes in climate alone can affect Northern Spotted Owl life-history traits. Franklin et al. 2000 found:

> "Climate explained most of the temporal variation in life history traits. Annual survival varied the least over time, whereas recruitment rate varied the most, suggesting a ''bet-hedging'' life history strategy for the owl. A forecast of annual rates of population change (l), estimated from life history traits, suggested that Northern Spotted Owl populations may change solely due to climate influences, even with unchanging habitat conditions." (Franklin et al. 2000, Abstract).

According to Franklin et al. 2000, climatic variation is one structured source of temporal variation that may affect avian populations through its influence on life history traits, largely in a density-independent manner (Boyce 1984). Extremes in climatic variation also can function as catastrophic events and have been associated with sudden large scale mortality in avian populations (Tompa 1971, Johnson et al. 1991, Rogers et al. 1991, Smith et al. 1991).(Franklin et al. 2000).

The U.S. Fish and Wildlife Service's Biological and Conference Opinions for the issuance of the Fruit Growers Supply Company Habitat Conservation Plan and Incidental Take Permit briefly summarize the potential impacts of climate change:

> Loarie et al. (2008) projected that up to 66 percent of California's endemic flora would experience >80 percent reductions in range size as a result of anticipated climate changes. While this is a worst-case scenario based on high levels of CO2 emissions in the future, a global climate model with high sensitivity to atmospheric greenhouse gas levels, and no dispersal component, the models ignore several factors that would exacerbate the projected impacts of climate change, including specialization to restricted soil types and the spread of invasive species…
>
> Despite variability in climate change simulations, consistent projections for warmer summers, reduced spring snowpacks, and earlier and more rapid snowmelt suggest that forests in California and the Pacific Northwest will experience longer fire seasons and more frequent, extensive, and severe fires in the future (Flannigan et al. 2000, Lenihan et al. 2003a, Whitlock et al. 2003, McKenzie et al. 2004). (U.S. Fish and Wildlife Service 2012).

The FWS specifically discussed the potential impacts of climate change on NSO in this same document:

> Climate change, a potential additional threat to northern spotted owl populations, is not explicitly addressed in the NWFP. Climate change could have direct and indirect effects on northern spotted owls and their prey. Based upon a global meta-analysis, Parmesan and Yohe (2003) discussed several potential implications of global climate change to biological systems, including terrestrial flora and fauna. Results indicated that 62 percent of species exhibited trends indicative of advancement of spring conditions. In bird species, trends were manifested in earlier nesting activities. Because the northern spotted owl exhibits a limited tolerance to heat relative to other bird species (Weathers et al. 2001), subtle changes in climate have the potential for significant negative effects. However, the direct effects of climate change to the species are unknown. *Id.*

The Department must critically evaluate the potential threats to the Northern Spotted Owl that may result from climate change. Changes in climate are significant factors affecting the survival and enhancement of the Northern Spotted Owl now and into the future. The Department must give serious consideration to the best available evidence related to changes in climate.

IV. Conclusion

The best available information clearly establishes the necessity to list the Northern Spotted Owl under CESA. The best quality information identifies NSO declines in fecundity, apparent survival, population trends throughout the state and throughout the species' range, and the realities of ongoing habitat loss and the incursion of barred owls. The Northern Spotted Owl warrants listing as either a "threatened" or "endangered" species.

We appreciate the opportunity to provide comments to the Department to inform its status review. EPIC will follow this process closely and provide additional comments when the status review is available for public comment. Please do not hesitate to contact me at the number provided below if additional information is required or if there are questions about anything we present here.

Sincerely,

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Z'berg Nejedley Forest Practices Act of 1973 (4 Pub. Res. Code Ch. 8).

Ebbetts Pass Forest Watch
A Forest & Watershed Coalition

Sent to wildlifemgt@wildlife.ca.gov on date shown below

May 1st, 2014

California Department of Fish and Wildlife
Nongame Wildlife Program
Attn: Neil Clipperton
1812 9th Street
Sacramento, California 95811

Re: Comments Regarding CDFW Status Review for the Northern Spotted Owl (*Strix occidentalis caurina*)

Dear Mr. Clipperton and Department Officials:

The undersigned conservation organizations submit the following comments on the California Department of Fish and Wildlife Status Review for the Northern Spotted Owl (*Strix occidentalis caurina*) (NSO) pursuant to the California Endangered Species Act (CESA). Please consider these comments as part of the Department's review.

The available evidence supports the conclusion that the Northern Spotted Owl warrants listing as either "threatened" or "endangered" under CESA. The Northern Spotted Owl warrants listing under CESA because it meets several of the criteria for listing a species as specified under the Act. Specifically, the NSO warrants listing due to the following factors: 1) past, present, and threatened habitat destruction, modification or curtailment; 2) competition from invasive species; 3) inadequate regulatory mechanisms; 4) climate change.

The status and trends of NSO in California on both public and private lands show continued declines in NSO fecundity, apparent survival, and population trends (e.g. Forsman et al. 2011). The best available evidence clearly points to habitat loss and the incursion of the invasive and aggressive barred owl among the primary reasons for declines in NSO across the species' range, and in California specifically.

There is ample evidence available to the Department via long-term, independent, and peer-reviewed literature to show that the NSO warrants listing as either "threatened" or "endangered."

Long-term demographic studies such as Forsman et al. 2011 demonstrate that both public and private lands study areas show declines in key indicating factors. It is critical that the Department conduct its review with scientific rigor, and that it appropriately weighs available evidence based on the strengths of said evidence. We encourage the Department to seek and consider evidence of the highest quality and that represents the best available science.

CESA requires the Department to consider the best available information, but does not require certainty in the science or evidence. The Department must, therefore, conduct its evaluation through the lens of the best, most rigorous and most credible evidence.

The Northern Spotted Owl is clearly in decline in California and throughout its range, and is faced with a myriad of threats, and therefore warranting listing as either "threatened" or "endangered" under CESA. We appreciate the opportunity to provide comments to the Department and are happy to answer any questions that the Department may have.

Sincerely,

Susan Jane Brown
Western Environmental Law Center

George Sexton
Klamath-Siskiyou Wildlands Center

Kimberly Baker
Klamath Forest Alliance

Justin Augustine
Center for Biological Diversity

Steve Holmer
American Bird Conservancy

Jodi Frediani
Central Coast Forest Watch

Larry Glass
Safe Alternatives for our Forest Environment

Daniel Ehresman
Northcoast Environmental Center

Paul Hughes
Forests Forever

Marily Woodhouse
Battle Creek Alliance

Susan Robinson
Ebbetts Pass Forest Watch

From: Stu Farber
To: Wildlife Management
Subject: Northern spotted owl 12-month review comments
Date: Tuesday, March 11, 2014 12:31:23 PM
Attachments: WBA Comments on NSO petition 3414.docx
Farber and Kroll 2012.pdf
Farber and Whitaker 2005.pdf
Irwin et al 2012.pdf
NSORP Updated 31114.pdf

Neil,

Attached are comments and information regarding the 12-month review of the Northern spotted owl. If you have any questions or need additional information, please feel free to contact me.

Stu

Stuart Farber
Wildlife Biologist
WM Beaty & Associates
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March 11, 2014

VIA E-MAIL

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Nongame Wildlife Program
Attn: Neil Clipperton
1812 9th Street
Sacramento CA 95811

Dear Mr. Clipperton;

Attached are several studies of Northern spotted owl (*Strix occidentalis caurina*) conducted on private forestlands in Siskiyou and Shasta County, California. Also attached is our Northern Spotted Owl Resource Plans (NSORP) that currently directs forest management activities on W.M. Beaty and Associates managed lands. We are providing these studies and management plans to you during your evaluation of a petition to list Northern spotted owl as a threatened or endangered species under the California Endangered Species Act.

Farber, S.L. and A.J. Kroll 2012 Site occupancy dynamics of Northern spotted owls in managed interior Douglas-fir forests, California, USA, 1995-2009. This published manuscript was based on 1,282 individual surveys and 480 spotted owl detections and 13 barred owl detections over 15 years. Average per visit detection probability (95% CL) for single and pair spotted owls was 0.93 (0.90−0.96) for informed daytime, stand-based searches and 0.47 (0.43−0.53) for nighttime, station-based surveys (estimated from the best model); the average per visit detection probability from the null model was 0.67 (0.63−0.70). Results suggest that a combination of 1 informed stand and 2 station-based operational surveys can support determinations of spotted owl site status (either a single or a pair) at desired levels of confidence. However, our information was collected in an area where barred owls were rarely detected. Surveys conducted in areas that support well-established barred owl populations are likely to be less effective for determining presence/absence of spotted owls and may require more surveys and/or different survey methods to determine site status with confidence.

Spotted owl site occupancy probability declined from 0.81 (0.59−0.93) in 1995 to 0.50 (0.36−0.63) in 2009; pair occupancy declined from 0.75 (0.49−0.91) to 0.46 (0.31−0.61). The resulting 39% decline across the 15 years of the study or approximately 2.6% annually slowed in the final 5 years of the study. However, while modeled probabilities declined 2.6% annually, the number of sites declared unoccupied or abandoned during the study period resulted in only a 9% decline across 15 years or approximately 0.6% annually. These actual site occupancy results are consistent with the reported small local-extinction and colonization probabilities which suggest relatively low turn-over at individual owl sites over 15 years.

Irwin, L.L. and D.F. Rock, S.C. Rock 2012 Habitat selection by Northern spotted owls in mixed-conifer forests. This published manuscript was based on radio-telemetry of 71 spotted owls over 5 years in 3 study areas, one in the Southern Cascades of California. Spotted owl habitat selection models were most strongly influenced by abiotic factors with negative relationships with increased distance to nest, distance to stream and positive relationship to slope. In other words, owls disproportionately used habitats within 200-300m of nest sites, closer to streams and on steeper slopes. Also, higher basal area of conifer trees with 400m of nest sites were used disproportionately. Most importantly these abiotic factors were more predictive than variables traditionally use to describe suitable owl habitat like habitat type, size or seral stage. Through adaptive management these understandings are being inserted into Spotted Owl Management Plans (SOMP), Northern Spotted Owl Resource Plans (WBA NSORP 2011), habitat conservation measures and stand-search survey strategies.

Farber, S.L. and J. Whitaker 2005 Diets of Northern spotted owls in the Southern Cascades and Klamath Provinces of interior Northern California. This unpublished study found that in both the eastern Klamath and Southern Cascades provinces Northern spotted owls consume a wide variety of prey including 16 individual species of mammals, 5 species of birds, and 1 species of insect. Based on 339 individual prey items, woodrat sp.(60.6%) followed by Northern flying squirrel (28.2%) biomass were the primary prey species for Northern spotted owls in the eastern Klamath mountains. Woodrat sp. (46.6%) followed by Northern flying squirrel (34.1%) biomass were the primary prey species in the Southern Cascades. No independent variables including tree species, size or density were significant at predicting the percent of flying squirrel biomass for an owl site. Prey species habitat associations indicate that maintaining a variety of habitats within owl sites maybe be beneficial for foraging Northern spotted owls.

W.M. Beaty and Associates, Northern Spotted Owl Resource Plan (NSORP)
This NSORP was originally approved by Cal Fire in 2011 and has subsequently been amended to update the NSORP with the current USFWS protocol, USFWS technical assistance and current scientific findings.

We hope you find the information contained in these studies and management plans interesting and informative. If you have any questions or need any additional information, please contact me at stuf@wmbeaty.com or at (530)243-2783.

Sincerely,

W. M. BEATY & ASSOCIATES, INC.

Stuart Farber
Wildlife Biologist

cc. P. Battaglia

Electronic Attachments: Farber, S.L. and A.J. Kroll, 2012.
Irwin, L.L. and D.F. Rock and S.C. Rock, 2012.
Farber, S.L. and J. Whitaker, 2005.
W.M. Beaty & Associates, NSORP 2011

The Journal of Wildlife Management 76(6):1145–1152; 2012; DOI: 10.1002/jwmg.368

Population Ecology

Site Occupancy Dynamics of Northern Spotted Owls in Managed Interior Douglas Fir Forests, California, USA, 1995–2009

STUART L. FARBER, *W.M. Beaty & Associates, P.O. Box 990898, Redding, CA 96099, USA*
ANDREW J. KROLL,[1] *Weyerhaeuser Company, WTC 1A5, P.O. Box 9777, Federal Way, WA 98063, USA*

ABSTRACT Northern spotted owls (*Strix occidentalis caurina*) have received intense research and management interest since their listing as a threatened species by the United States Fish and Wildlife Service in 1990. For example, public and private forest managers in the Pacific Northwest, USA, conduct surveys to determine presence or absence of spotted owls prior to timber harvest operations. However, although recently developed statistical methods have been applied to presence–absence data collected during research surveys, the effectiveness of operational surveys for detecting spotted owls and evaluating site occupancy dynamics is not known. We used spotted owl survey data collected from 1995 to 2009 on a study area in interior northern California, USA, to evaluate competing occupancy models from Program PRESENCE using Akaike's Information Criterion (AIC). During 1,282 individual surveys, we recorded 480 spotted owl detections (37.4%) and 13 barred owl (1.0%) detections. Average per visit detection probability (85% CL) for single and paired spotted owls was 0.93 (0.90–0.96) for informed daytime, stand-based searches and 0.47 (0.43–0.51) for nighttime, station-based surveys (estimated from the best model); the average per visit detection probability from the null model was 0.67 (0.64–0.70). Average pair-only detection probabilities were 0.86 (0.81–0.90) for informed daytime, stand-based searches and 0.23 (0.18–0.29) for nighttime, station-based surveys; the average per visit detection probability from the null model was 0.63 (0.58–0.68). Site occupancy for any owl declined from 0.81 (0.59–0.93) in 1995 to 0.50 (0.39–0.60) in 2009; pair occupancy declined from 0.75 (0.56–0.87) to 0.46 (0.31–0.61). Our results suggest that a combination of 1 informed stand and 2 station-based operational surveys can support determinations of spotted owl site status (either a single or a pair) at desired levels of confidence. However, our information was collected in an area where barred owls were rarely detected. Surveys conducted in areas that support well-established barred owl populations are likely to be less effective for determining presence or absence of spotted owls and may require more surveys and/or different survey methods to determine site status with confidence.

KEY WORDS California, colonization, detection probability, local-extinction, managed forests, northern spotted owls, occupancy, operational surveys, *Strix occidentalis caurina*.

The northern spotted owl (*Strix occidentalis caurina*) has been a federally listed threatened species since 1990 and remains the focus of numerous conservation, management, and research programs in the Pacific Northwest, USA. The primary focus of research efforts for spotted owls has been demographic studies that estimate survival, productivity, and changes in population growth rate (Franklin et al. 2000, Anthony et al. 2006), although several efforts have examined site occupancy probabilities and potential sources of variation in these probabilities (Meyer et al. 1998, Swindle et al. 1999). Recent analyses used data collected on demographic monitoring areas, where the main objectives were to monitor adult survival and fecundity (Anthony et al. 2006), to examine northern spotted owl occupancy dynamics (Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011). Site occupancy probabilities can be useful metrics for monitoring how long-lived, territorial species such as the spotted owl respond to changes in environmental conditions, anthropogenic impacts, and co-occurring species.

Public and private forestland owners in California, Oregon, and Washington conduct presence–absence surveys for spotted owls prior to timber harvest operations to avoid indirect or direct impacts to spotted owls that occur within project areas. These operational surveys are planned and conducted based on widely accepted field methods and recommended United States Fish and Wildlife Service (USFWS) protocol (Forsman 1983, USFWS 1992). However, little information about the effectiveness of these operational surveys is available. For example, available spotted owl detection probabilities have been estimated from information collected in

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long-term research studies that use different methods than operational surveys (Olson et al. 2005, Anthony et al. 2006, Kroll et al. 2010).

In addition, the effectiveness of research surveys has been reduced across a wide portion of the northern spotted owl's distribution by the occurrence of barred owls (*Strix varia*), which have a negative association with spotted owl detection probabilities and may lead to misclassification of site occupancy status (Olson et al. 2005, Kroll et al. 2010). The barred owl has rapidly expanded its range in the Pacific Northwest since 1990 (Taylor and Forsman 1976, Herter and Hicks 2000, Kelly et al. 2003), and the consequences for spotted owl populations have been mostly negative (Kelly et al. 2003, Haig et al. 2004). For example, studies have found that barred owls were negatively associated with spotted owl productivity, adult survival, and occupancy (Olson et al. 2004, 2005; Anthony et al. 2006). However, the density of barred owls varies widely across the range of the northern spotted owl, and barred owls appear to be more numerous in Oregon and Washington than in California (Courtney et al. 2008). Information collected in areas where barred owls occur only infrequently would presumably provide a more accurate understanding of typical variation in detection probabilities and spotted owl population trends, and preclude the need to adjust statistical analyses to account for the influence of barred owls.

Our objectives were to evaluate annual variation and potential temporal trends in detection, local-extinction, colonization, and occupancy probabilities of northern spotted owls on a study area in interior northern California that lacks a well-established population of barred owls. In addition, we evaluated the association of pair nesting status and biological province (Klamath and Cascades) with spotted owl detection and occupancy probabilities.

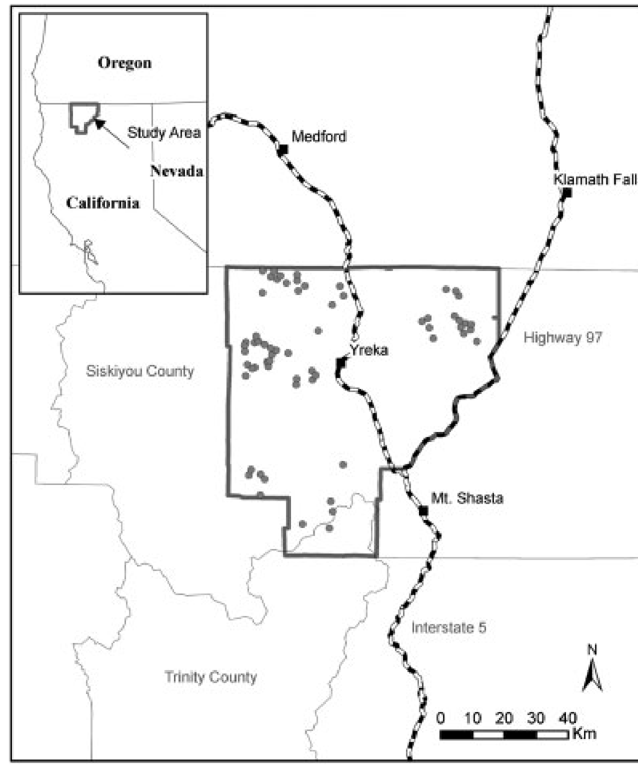

Figure 1. General outline of the northern spotted owl study area, Siskiyou and Trinity Counties, northern California, USA, 1995–2009. Gray dots reference individual northern spotted owl sites.

STUDY AREA

The study area covered approximately 5,850 km^2 of the eastern Klamath and southern Cascade Mountains in Trinity and Siskiyou Counties, California, USA (Fig. 1). The spotted owl territories were located at elevations ranging from 1,000 m to 1,500 m. The study area was characterized by relatively steep mountainous terrain with a Mediterranean climate of warm, dry summers and cool, moist winters, with approximately 80% of the precipitation occurring from November to March. The dominant forest vegetation types in the Klamath Mountains included Klamath mixed conifer, Douglas-fir, and montane hardwood-conifer, whereas the Southern Cascades were dominated by Klamath mixed conifer, white fir, and red fir types (Mayer and Laudenslayer 1988). Coniferous forest stands were composed of Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), and white fir (*Abies concolor*), with an understory composed of Oregon white oak (*Quercus garryana*), incense cedar (*Calocedrus decurrens*), snowbrush (*Ceanothus cordulatus*), and dwarf Oregon grape (*Berberis nervosa*; Mayer and Laudenslayer 1988).

We collected data from spotted owl sites located on both private forestland and portions of the Klamath and Shasta-Trinity National Forests. Private forestland, originated from land grant railway ownership, was typically intermingled with United States Forest Service ownership in a checkerboard pattern. Forest management had occurred on the private forests for over 80 years, resulting in a forest landscape mosaic of young, intermediate, and mature forests (ranging from 80 to 120 years old). During our study period, silvicultural prescriptions on private forests included clearcut-variable retention, shelterwood removal, and commercial thinning. The clearcut-variable retention prescription retained a variety of green tree species, snags, wildlife trees, and large downed woody debris (Hansen et al. 1991, Swanson and Franklin 1992) to increase future stand complexity for species such as northern spotted owls and their prey (Thome et al. 1999, Irwin et al. 2000, Sullivan and Sullivan 2001). Prescriptions on United States Forest Service ownership were implemented to support the Northwest Forest Plan (United States Department of Agriculture 1993) and included stands that were thinned or selectively managed to reduce risk of catastrophic fire as well as late-successional reserves.

METHODS

Field Surveys and Data Preparation

Various public and private monitoring programs have surveyed northern spotted owl sites in the Klamath and Southern Cascades provinces since the late 1980s. The territorial nature of spotted owls allowed for the development of a public database of known owl sites. Our study included data from a portion of the spotted owl sites contained in the public database and we only included data from surveys that were conducted from 1995 to 2009. We did not include data for years prior to 1995 because of an unbalanced and inconsistent survey effort which could have biased our results. Although we did not include pre-1995 data in our analyses, our dataset included spotted owl sites where at least 1 owl had been detected during the March–August breeding season prior to 1995 as well as spotted owl sites where owls were first detected after 1995. We added these new sites if they were within our study area boundaries and if subsequent surveys were consistent and met our criteria described below. We conducted surveys to monitor selected known sites and to evaluate occupancy of sites prior to, and following, timber management activities. We included 63 spotted owl sites that met our criteria in our occupancy analyses. Sixteen of these sites occurred in the Southern Cascades and 47 occurred in the Klamath Mountains province.

We conducted surveys following recommended field methods (Forsman 1983, USFWS 1992). Typically, we conducted surveys (consisting of 3 visits per year) were conducted over 2 years, resulting in a minimum of 6 visits to a survey area to meet the protocol standard. One complete survey visit included a nighttime station survey (hereafter, night survey) and, if necessary, a subsequent stand search during the day to find spotted owls detected the previous night. A night survey consisted of imitating spotted owl vocalizations, by either voice or digital recording, for 10 min at each survey station located within a specific owl site. The spotted owl territory provincial radius, a circle that approximates the annual home range for spotted owls, for the Southern Cascades and Klamath Mountains is 2.1 km (USFWS 1992). For this study, we only included surveys that completely covered, at a minimum, a 1.1-km radius from the defined site center.

In addition, we often conducted an informed daytime stand search (hereafter, informed day search) prior to beginning night surveys. We conducted informed day searches, primarily within spotted owl core use areas (Blakesley et al. 1992, Bingham and Noon 1998, Zabel et al. 2003), by following routes developed by biologists using historical and current biological information gathered at the sites. Historical and current biological knowledge included 1) historic or current location of spotted owl sites; 2) suitable habitat within sites; 3) previous spotted owl detection locations; 4) previous nest and roost locations; and 5) location of abiotically favored suitable habitat (Clark 2002, Underwood et al. 2010). This information was readily available in a spatial database to biologists, survey personnel, and forest managers when planning and conducting surveys. Although we had limited information for some spotted owl sites, we had territory location and suitable habitat maps for all sites. Accordingly, we considered all of our day searches informed relative to naïve surveys (Riddle et al. 2010). In our analysis, we did not consider follow-up stand searches (e.g., conducted after a detection on the previous night) as informed day searches, as this decision would have added a positive bias to our results.

If spotted owls were detected during either the night surveys or informed day searches, we summarized the results into 1 of 4 status categories: single, pair, nesting pair, or reproductive pair (following recommendations in Forsman 1983 and USFWS 1992). We designated detections as single when only an individual spotted owl was detected and made a pair designation when both a male and female were detected within the site. We made a nesting pair designation when, after 15 April, a female spotted owl was observed on a nest or a male owl was observed taking a prey item to a female on a nest. We made a reproductive pair designation when a nesting pair had confirmed fledglings outside the nest structure. We typically conducted surveys prior to forest management operations to determine the occupancy and reproductive status of spotted owls; consequently, surveys did not always determine final nest fate or total number of young fledged. Finally, we did not attempt to detect barred owls using barred owl vocalizations. As a result, we detected barred owls opportunistically during spotted owl surveys.

Spotted owl sites are maintained by either a mated pair or a resident single bird (often a male). To reflect this distinction, we created 2 data sets: 1 data set contained detections of single birds (either M or F) and pairs (simple detections) and the second data set contained detections of pairs only (Olson et al. 2005, Kroll et al. 2010). Occupancy probabilities that we estimated from the former data set are likely to be greater and represent an upper bound of site occupancy. We refer to the analyses based on these 2 data sets as simple and pair, respectively.

Detection and Site Occupancy Modeling and Parameter Estimation

We based our analysis of site occupancy models on methods designed for open populations and described by MacKenzie et al. (2003, 2006) and employed specifically to analyze spotted owl data by Olson et al. (2005), Kroll et al. (2010), and Dugger et al. (2011). The primary sampling occasions were years and the secondary sampling occasions were the 3 individual visits that occurred during the spotted owl nesting season (Mar–Aug) to site-centers (i.e., known nest-sites or areas of concentrated use) or call stations distributed throughout owl territories.

We employed a 2-step process to estimate occupancy parameters. First, we modeled those covariates that we thought would influence detection probabilities. In the second step, we used the best detection model and evaluated combinations of time effects (., T, and TT). We then added a province (either the Klamath or Cascades) or a nesting status covariate (for pairs only) as an additive effect on local-extinction (probability that an occupied site became unoccupied in the following year) and colonization (probability that an unoccupied site became occupied in the following year) to time trend models with the lowest Akaike's Information Criterion with small sample correction (AIC_c) and models with $\Delta AIC_c < 2.0$ (Burnham and Anderson 2002). We calculated year-specific (denoted as t) site occupancy probabilities based on estimated local-extinction and colonization probabilities (following MacKenzie et al. 2003). We conducted analyses with Program PRESENCE (PRESENCE Version 3.0 beta, www.mbr-pwrc.usgs.gov/software/doc/presence/presence.html, accessed 1 Apr 2010). We used AIC_c for model selection and considered models with $\Delta AIC_c < 2.0$ as being substantially supported (Burnham and Anderson 2002). We used the logit link function for all models so that parameter estimates and 85% confidence intervals would be constrained to the interval 0–1.

We modeled several temporal structures for within-season detection probabilities, including constant (denoted as [.]), a linear trend (T), a quadratic trend (TT), and an unconstrained model (t). Within-season linear and quadratic time trends are equivalent to evaluating an effect of Julian date. Also, we evaluated year-specific, linear, and quadratic temporal trends across years. We did not consider unspecified within season and annual temporal models simultaneously, as they would have required too many parameters (i.e., a different parameter for each of the 45 visits across the study period).

We did not monitor all spotted owl site centers each year, resulting in different sample sizes in each year. As a result, we used only 3 temporal covariates (., T, and TT) to evaluate models of local-extinction and colonization (i.e., we did not model unspecified annual variation, t). We used the initial occupancy (probability that a site was occupied in 1995) parameterization in PRESENCE but we did not consider any spatial variation in initial occupancy. We added the province and nesting status covariates to the models with the most support (smallest AIC_c and $\Delta AIC_c \leq 2$). We evaluated the nesting status covariate in local-extinction models only. We evaluated whether nesting status in year i might be associated with spotted owl local-extinction in the interval between year i and year $i + 1$. Unlike other studies that investigated occupancy dynamics of spotted owls (Kroll et al. 2010, Dugger et al. 2011), we did not evaluate a barred owl covariate because barred owls were transient and rarely detected during our study. We evaluated effect sizes for covariates by examining parameter estimates and associated 85% confidence intervals; if effect sizes were large and 85% confidence intervals did not include zero, we considered the association to have support from the analysis (Arnold 2010). Finally, we note that spotted owl territories chosen for monitoring were located opportunistically over time, similar to other studies (Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011). As a result, inference from our study is restricted to spotted owl territories that are either currently occupied or were occupied at some point in the past, rather than all potential spotted owl territories in our study area.

RESULTS

Of the 63 spotted owl sites that met our criteria, 54 were known in a public database prior to 1995 and 9 spotted owl sites were discovered during the study. Sixteen (25%) and 47 (75%) spotted owl sites occurred in the Southern Cascades and Klamath Mountains, respectively. The number of spotted owl detections per site ranged from 0 to 30 ($\bar{x} = 7.6$; 95% CI = 5.5–9.7) from 1995 to 2009; 10 sites had 0 detections during our study period.

Table 1. Regression coefficients and 85% confidence intervals from the top ranked simple and pair spotted owl detection models, northern California, USA, 1995–2009. Night indicates the effect of conducting a nighttime, station-based survey; the intercept includes the effect of conducting a daytime, stand-based search.

Occupancy level	Model term	$\hat{\beta}$	SE	85% CL
Simple	Intercept	2.60	0.259	2.22 to 2.97
	Night	−2.71	0.282	−3.12 to −2.29
Pair	Intercept	1.90	0.223	1.58 to 2.22
	Time	−0.47	0.151	−0.69 to −0.25
	Night	−3.15	0.271	−3.54 to −2.76

One thousand thirty-three of 1,282 surveys (81%) occurred at night. A total of 480 (37.4%) spotted owl detections and 13 (1.0%) barred owl detections occurred during the 1,282 surveys. Barred owls were detected in 6 of 16 sites (38%) in the Southern Cascades and 2 of 47 sites (4%) in the Klamath Mountains province. During our study period, we did not detect barred owls in 1995 and 1996; however, we detected 4 barred owls from 1997 to 2004, 8 barred owls in 2005 and 2006, and 1 barred owl from 2007 to 2009. We detected a barred owl in multiple years on 1 spotted owl site; for the remaining 7 sites, we detected a barred owl in $\leq$1 year.

Detection Probabilities

The best model for detection probability in the simple analysis contained an effect for search type (informed day search or night survey; Table 1). Survey-specific simple detection probabilities were 0.93 (85% CI = 0.90–0.96) and 0.47 (85% CI = 0.43–0.51) for informed day searches and night surveys, respectively. The best model for detection probability in the pair analysis contained a negative linear annual trend and an effect for search type (Table 1 and Fig. 2). The average pair detection probabilities across all years were 0.86 (85% CI = 0.81–0.90) and 0.23 (85% CI = 0.18–0.29) for informed day searches and night surveys, respectively. Average detection probabilities (for all surveys combined) were 0.67 (85% CI = 0.64–0.70) and

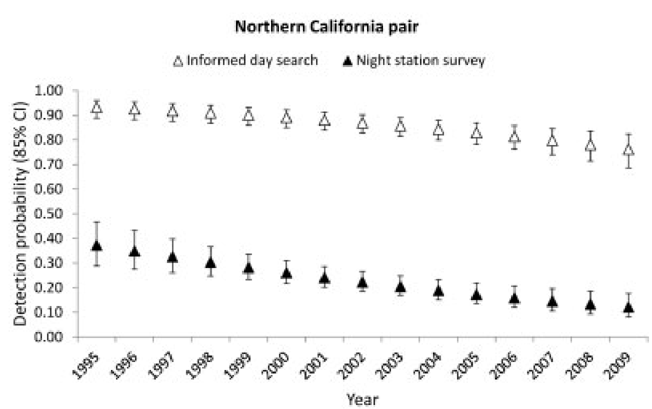

Figure 2. Estimated year-specific northern spotted owl pair detection probabilities and 85% confidence intervals, northern California, USA, 1995–2009. Open and filled diamonds represent estimates for surveys conducted during the day and night, respectively.

0.63 (85% CI = 0.58–0.68) for the simple and pair analyses, respectively (estimated with the null model). We did not find support for a difference in detection probabilities between the Southern Cascades and Klamath Mountains province.

Local-Extinction and Colonization Probabilities

Initial occupancy probabilities were 0.81 (85% CI = 0.59–0.93) and 0.75 (85% CI = 0.56–0.87) for the simple and pair analyses, respectively. The most supported model in the simple analysis included a negative linear trend in colonization probabilities; a model where colonization probability did not change during the study was the most supported in the pair analysis (Table 2). A constant local-extinction model received the most support in both the simple and pair analyses (Tables 2 and 3). Although the model weight indicated support for an effect of province on local-extinction probability in the simple analysis, the 85% confidence interval overlapped 0, suggesting uncertainty about the effect. The same was true for other covariates in both the simple (e.g., a linear trend in local-extinction) and the pair (e.g., an effect of nesting status on local-extinction and an effect of province on colonization) analyses (Table 2).

Local-extinction probabilities (from the best model) were constant across the study period for both the simple (0.09, 85% CI = 0.06–0.12) and pair (0.09, 85% CI = 0.06–0.13) analyses (Table 3). Colonization probabilities declined across the study in the simple analysis (Fig. 3 and Table 3) and remained constant in the pair analysis (0.06, 85% CI = 0.04–0.12).

Site Occupancy Probabilities

We present derived parameter estimates for simple and pair annual site occupancy probabilities for spotted owls based on best model estimates of initial occupancy, local-extinction, and colonization in our study area (Fig. 3). Site occupancy for any owl declined from 0.81 (85% CI = 0.59–0.93) in 1995 to 0.50 (85% CI = 0.39–0.60) in 2009; pair occupancy declined from 0.75 (85% CI = 0.56–0.87) to 0.46 (85% CI = 0.31–0.61). However, the rate of decline slowed for pair occupancy probabilities in the final 5 years of the study.

Table 3. Estimates and 85% confidence intervals for colonization and local-extinction coefficients from the top ranked simple and pair spotted owl occupancy models, northern California, USA, 1995–2009.

Occupancy level	Model term	$\hat{\beta}$	SE	85% CL
Simple	$\text{Intercept}_{\text{Colonization}}$	−2.15	0.33	−2.63 to −1.67
	$\text{Time}_{\text{Colonization}}$	−0.66	0.43	−1.29 to −0.03
	$\text{Intercept}_{\text{Extinction}}$	−2.34	0.24	−2.69 to −1.99
Pair	$\text{Intercept}_{\text{Colonization}}$	−2.59	0.43	−3.21 to −1.96
	$\text{Intercept}_{\text{Extinction}}$	−2.31	0.31	−2.76 to −1.86

DISCUSSION

We found that simple and pair spotted owl occupancy probabilities declined approximately 39% across the 15 years of our study, although the decline in pair occupancy probabilities appeared to slow in the final 5 years of the study. Observed pair declines in our study area were less than those reported for the Wenatchee study area in Washington, which demonstrated declines of 15% and 50% in simple and pair occupancy (Kroll et al. 2010), but greater than those for 3 study areas in western Oregon, only 1 of which demonstrated a decline of >10% (Olson et al. 2005). These declines in site occupancy are consistent with the trend in realized population change for the northwestern California demographic study area, which has been declining since 1992 (Anthony et al. 2006).

We found evidence that changes in simple occupancy probabilities were likely the result of declining colonization probabilities. Kroll et al. (2010) found that simple and pair

Table 2. Best ranked northern spotted owl site occupancy models (cumulative weight ≥0.85), northern California, USA, 1995–2009. For simple occupancy models, the detection probability model was $P_{\text{Day or Night}}$ (detection was a function of either day stand search or night station survey; 2 parameters); for pair occupancy models, the detection probability model was $P_{\text{T, Day or Night}}$ (detection was a function of a linear trend across years and day stand search or night station survey; 3 parameters). Model parameters include ψ (occupancy), γ (colonization), and ε (local-extinction); covariates include linear (T) and quadratic (TT) effects of time, Province (Klamath or Cascades), and Nesting status (whether a pair was nesting during the survey year).

Occupancy level	Model	K[a]	AIC_c	ΔAIC_c	w_i	Deviance
Simple	ψ(.)γ(T),ε(.)	6	1,153.0	0	0.20	1,141.0
	ψ(.)γ(.),ε(.)	5	1,153.1	0.1	0.19	1,143.1
	ψ(.)γ(.),ε(Province)	6	1,153.1	0.1	0.19	1,141.1
	ψ(.)γ(.),ε(T)	6	1,154.5	1.5	0.09	1,142.5
	ψ(.)γ(T),ε(T)	7	1,155.0	1.9	0.07	1,141.0
	ψ(.)γ(TT),ε(.)	7	1,155.0	2.0	0.07	1,141.0
	ψ(.)γ(Province),ε(.)	6	1,155.1	2.1	0.07	1,143.1
	ψ(.)γ(T),ε(.)	6	1,153.0	3.4	0.04	1,141.0
Pair	ψ(.)γ(.),ε(.)	6	842.5	0	0.21	830.5
	ψ(.)γ(.),ε(Nesting status)	7	843.4	0.9	0.13	829.4
	ψ(.)γ(Province),ε(.)	7	843.7	1.2	0.12	829.7
	ψ(.)γ(T),ε(.)	7	844.0	1.5	0.10	830.0
	ψ(.)γ(.),ε(Province)	7	844.5	2.0	0.08	830.5
	ψ(.)γ(.),ε(T)	7	844.5	2.0	0.08	830.5
	ψ(.)γ(Nesting status),ε(.)	7	844.5	2.0	0.08	830.5
	ψ(.)γ(TT),ε(T)	9	845.3	2.8	0.05	827.3

[a] K = the number of parameters in the model; AIC_c = Akaike's Information Criterion adjusted for small sample sizes; ΔAIC_c = difference in AIC_c between top model and each subsequent model; w_i = Akaike weight; deviance = residual sum of squares.

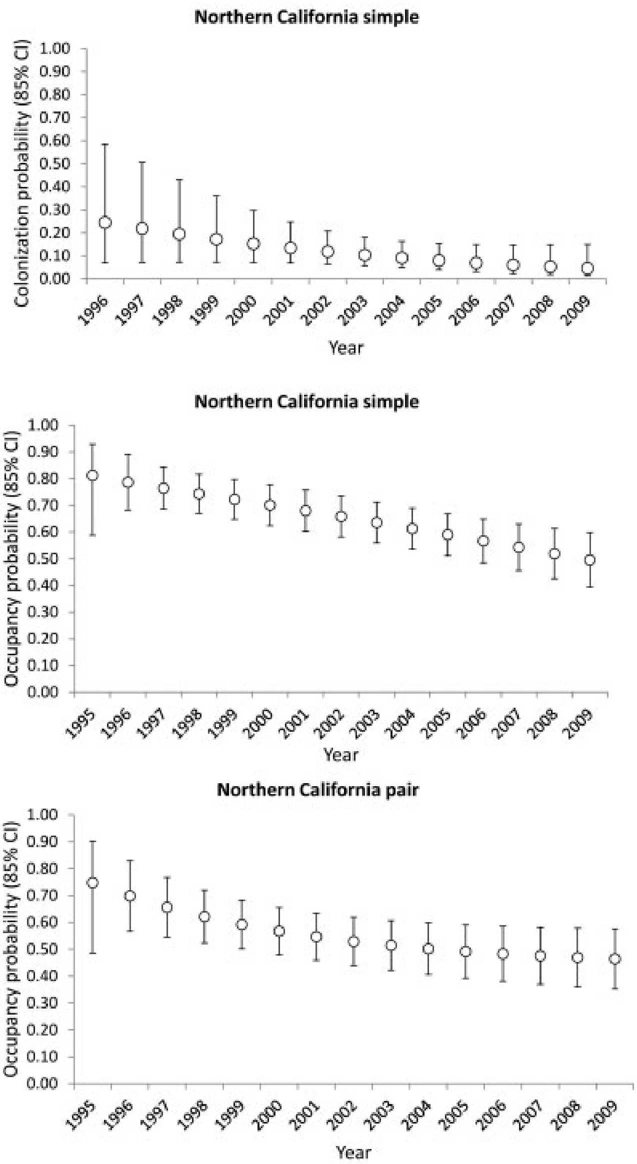

Figure 3. Estimated year-specific simple colonization probabilities and simple and pair occupancy probabilities with 85% confidence intervals for northern spotted owls, northern California, USA, 1995–2009. We calculated occupancy probabilities from the most supported models of initial occupancy, local-extinction, and colonization and using formulae from MacKenzie et al. (2003).

colonization probabilities declined during the 14 years included in their study; in contrast, Olson et al. (2005) found a consistent decline in simple colonization probabilities for only 1 of 3 study areas in Oregon; the other 2 simple colonization probabilities either increased or remained constant through time, while 1 pair colonization probability remained constant through time and 2 declined from initial levels before increasing during the last 6 years of the study. Simple colonization probabilities may have declined in our study area because recruitment declined during the study; as a result, the pool of floaters (individuals prospecting for territories) declined. We did not measure juvenile survival or emigration, so we cannot address this hypothesis. In addition, the estimated probabilities of local-extinction and colonization for both simple and pair spotted owls were small, suggesting relatively low turn-over at individual spotted owl sites.

Barred owls appeared to have occurred only as transients in our study area, suggesting that other factors were responsible for observed declines in site occupancy and corresponding differences in site occupancy estimates between our study area in northern California and results reported for Oregon and Washington (Olson et al. 2005, Kroll et al. 2010, Dugger et al. 2011). Differences in habitat types (dominant tree species and understory vegetation) and disturbance regimes (size and frequency of fires, differences in harvesting practices) are 2 primary sources of spatial variation that we were unable to model in our analysis. Specifically, we were unable to evaluate how much the amount of older forest within each spotted owl site may have influenced site occupancy dynamics. Olson et al. (2005) hypothesized that greater occupancy probabilities on 1 of their 3 study areas was a result of sites on that study area containing a greater proportion of older forest than the other 2 sites. Dugger et al. (2011) found that local-extinction probability was negatively associated with the percentage of old forest ($\geq$100 years of age) in the spotted owl site core (167-ha circle centered on the nest site). We also did not evaluate how the range of management intensity in our study area may have been associated with site occupancy dynamics. Spotted owl sites occurred on federal and private ownerships, portions of which were managed passively or actively. However, we did not have annual habitat data for all of the spotted owl sites that would allow us to model habitat-based variation in local-extinction and colonization probabilities. Collection of detailed habitat data over an extensive period, and with a resolution that accurately quantifies spotted owl habitat characteristics, poses a challenge to managers and researchers, but these attributes are probably critically important for explaining and managing spotted owl occupancy dynamics (Carey et al. 1992, Franklin et al. 2000).

In general, detection probabilities for spotted owls were $<$1.0 and variable, a result that agrees with other analyses using the same methods (Olson et al. 2005, Kroll et al. 2010). Average detection probabilities (across all years) were similar to detection probabilities reported by Reid et al. (1999) and Olson et al. (2005) as well as some of the years presented by Kroll et al. (2010). We did not find strong associations between province and simple and pair detection probabilities, although low sample sizes in the Cascades ($n = 16$) may have limited our ability to detect differences. Also, we did not find an association between nesting status and pair detection probabilities.

Detection probabilities of spotted owls in both the simple and pair analyses were strongly associated with survey type. Specifically, during night surveys, spotted owl calls were broadcasted from established survey stations; during informed day searches, the best abiotic locations of suitable habitat within territory core areas was surveyed, resulting in greater average detection probabilities compared to night surveys. Varying amounts of information about individual territories could lead to variation in detection probabilities resulting from informed day searches. However, by including only spotted owl sites that received consistent survey effort informed by comparable amounts of site-specific knowledge in our dataset, we attempted to limit this source of variation. We suggest that other landowners consider gathering information on a site-specific basis, as this information can be used to increase survey-specific detection probabilities, thereby limiting the amount of resources dedicated to spotted owl survey programs. For example, because of the high detection probabilities associated with informed day searches (0.93 and 0.86 for simple and pair detections, respectively), including even 1 informed day search per season greatly increases confidence in the determination of spotted owl site occupancy status.

MANAGEMENT IMPLICATIONS

Site occupancy probabilities for spotted owl pairs appeared to have stabilized in the final 5 years of our study, although the continuing decline in simple occupancy probabilities, because of reduced colonization, merits further monitoring attention. In addition, we expect that occupancy probabilities will decline in the future if barred owls become as prevalent in the study area as they have in other portions of the spotted owl's geographic distribution or if habitat quality changes significantly (e.g., after a large wildfire). Based on the large differences in detection probabilities between informed day searches and station-based night surveys, we recommend that survey programs in our study area include at least 1 informed day search, directed by informed knowledge of site conditions, in each survey season to increase confidence in occupancy status. Conducting 1 informed day search along with a 2 visit annual night survey protocol will meet the USFWS standard for confidence in site status for simple spotted owls in the Klamath Mountains and Southern Cascades biogeographic provinces. We did not find support for a relationship between detection probabilities and survey date and suggest that informed day searches can be conducted throughout the survey season (although we recommend that surveys be conducted early in the breeding season to identify both breeding and non-breeding spotted owls). To increase confidence in determination of site occupancy status for spotted owl pairs, given the lower and declining pair detection probabilities, managers should include 2 informed day searches along with a 3 visit annual night survey protocol.

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Diets of Northern spotted owls (*Strix occidentallis caurina*) in the Southern Cascades and Klamath Provinces of interior Northern California.

PREPARED FOR :
The U.S. Fish & Wildlife Service
for the review of the Spotted Owl Management Plan

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February 2, 2005

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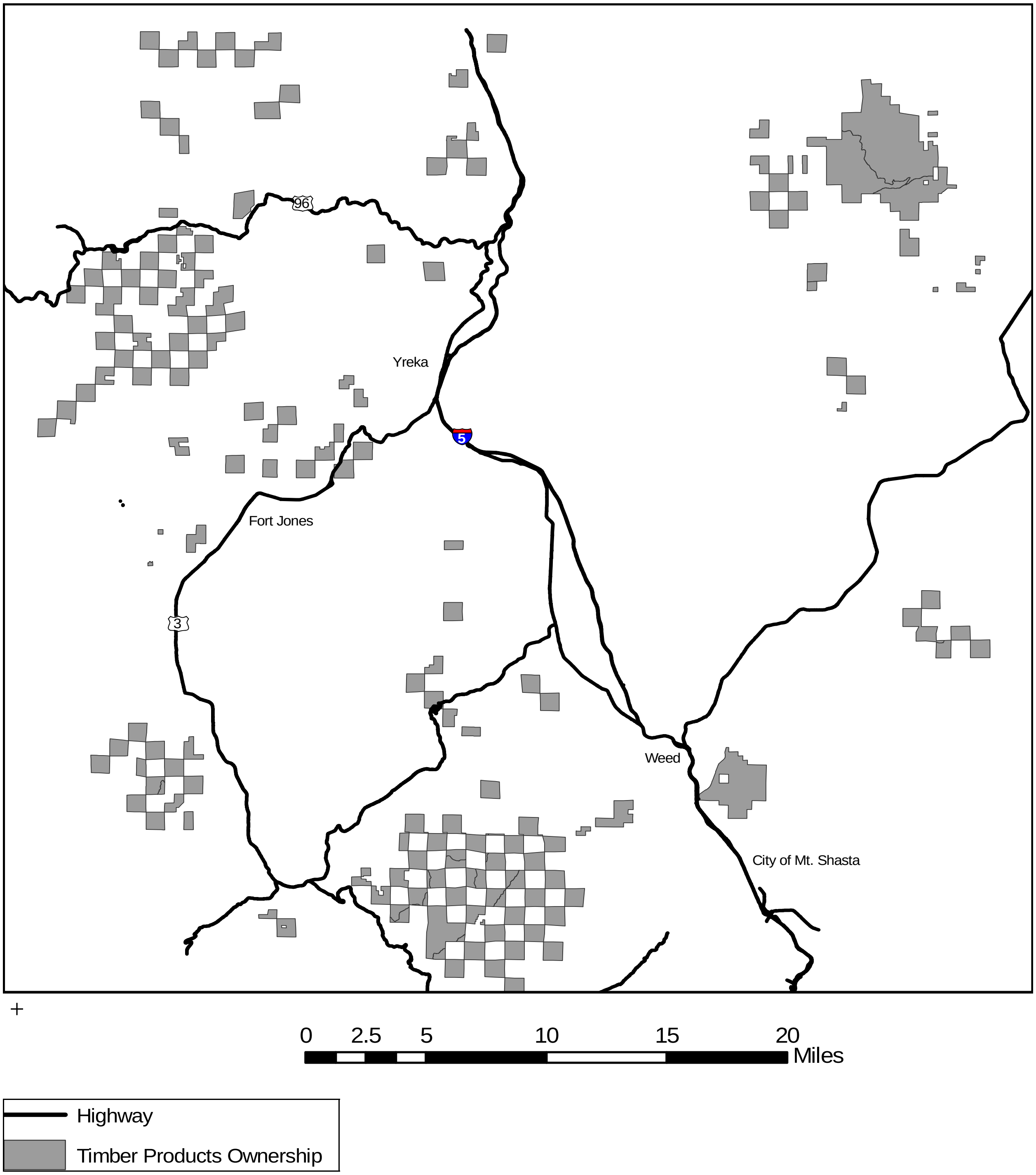
1.0 Introduction

Timber Products Company (Company) is a privately owned company whose primary objective is the long-term management of its forest resources while maintaining, protecting, and enhancing wildlife and fisheries resources. Timber Products owns and manages approximately 125,000 acres of forestland in interior Northern California (Figure 1). Since the majority of forestlands originate from railway land grants the "checkerboard" pattern ownership is typically intermingled with federal agencies supporting the Northwest Forest Plan. The four national forests adjacent to company ownership area the Klamath, Shasta-Trinity, Six Rivers, and Rogue River National Forests.

Over 80 Northern spotted owl (*Strix occidentallis caurina*) activity centers are located on or within 1.3 miles of Company forestlands. Long-term management of Company forest resources includes understanding how these forestlands provide suitable habitat for spotted owls. Accordingly, this study is part of monitoring the Company Spotted Owl Management Plan (2001) which uses new scientific information in an adaptive management process to develop future forest management plans.

Research has indicated that Northern spotted owl diets vary among regions and forest types (Forsman *et al*., 1984). Many studies have hypothesized that primary prey species and abundance are influences on home range size (Zabel *et al.*, 1995) and on habitat use (Carey *et al*., 1992). Spotted owls regurgitate the less-digestible portions of their prey, such as bones and hair, which can then be used to identify the species of prey. To better understand the foraging preferences of spotted owls in the interior northern California region, pellets were collected between 1996 and 2004 from 20 different Northern spotted owl activity centers on and adjacent to Company forestland.

Figure 1 Location of Company forestland in interior Northern California.



2.0 Study Areas

To better understand potential variability of spotted owl diets among ecological provinces and habitat types, pellets were collected from both the Klamath mountains and Southern Cascades provinces of California. Vegetation, parent geology and climate are the main ecological factors which separate these two distinct provinces (FEMAT 1993). The Klamath mountains province is located from the Oregon border south to the northern Sacramento valley and from Interstate 5 west to the redwood coast range. The Southern Cascades in California are located east of Interstate 5 from the Oregon border south to northern Sacramento valley (FEMAT 1993) (Figure 2).

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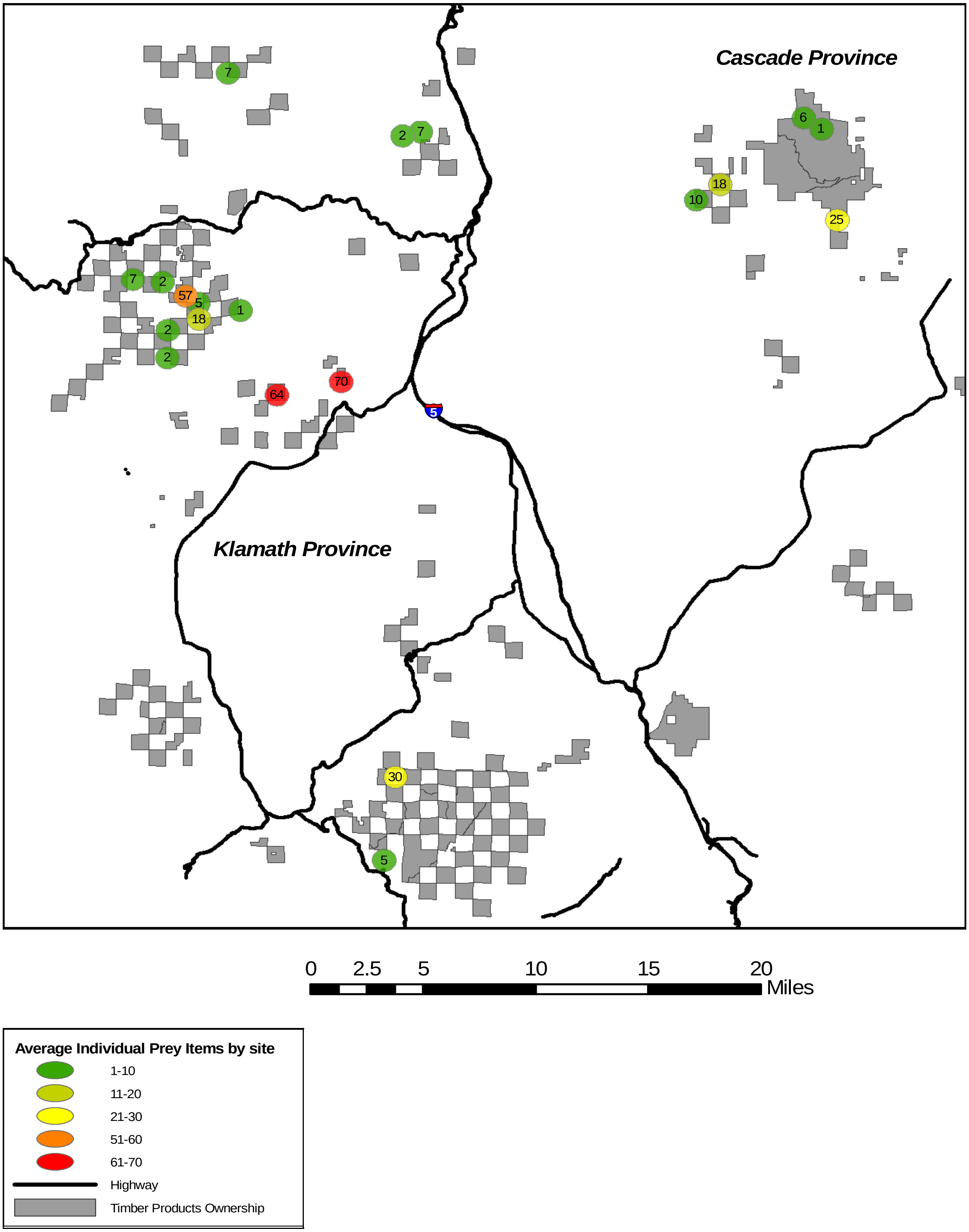
The climatic conditions within the Klamath province are characterized normally by cool, moist winters and warm, dry summers. Generally, precipitation falls as rain below 4,000 feet. Elevations of the spotted owl activity centers within this province, where pellets were collected, range from approximately 3,300ft to 5,100ft (1,000m to 1,550m). Vegetation types surrounding activity centers are dominated by Klamath Mixed Conifer, Ponderosa Pine, Douglas-fir, Montane Hardwood-Conifer, Montane Hardwood and Mixed Chaparral (Mayer and Laudenslayer 1988).

Within the Cascade Province, precipitation generally falls as rain below 4,000 feet, but it can rain during warm winter storms to as high as 7,000 feet. Snow can occur down to 1,000 feet, but generally accumulates above 4,000 feet. The spotted owl activity centers within this province range in elevation from 4,400ft to 5,300ft (1,340m – 1,615m). A wide variety of tree dominated forest types occur on Company forestlands including Klamath Mixed Conifer, Douglas-fir, White Fir, Red Fir, Ponderosa Pine, Montane Hardwood-Conifer, Juniper, Montane Hardwood and Mixed Chaparral (Mayer and Laundenslayer 1988).

Figure 2 **Distribution of Northern Spotted Owl Activity Centers**
Number of Individual Prey Items Collected by Site



3.0 Methods

From 1996 through 2004 northern spotted owl pellets were collected opportunistically as a part of USFWS protocol surveys and owl banding efforts. Pellets were collected below roosts and nests during the breeding season from March 1 to August 15. Only one pellet in the analysis was from outside the breeding season (September 29th, Cascade Province). For each pellet date, owl site number, location of pellet (nest, roost, or unknown) and sex of the owl (male, female or unknown) were recorded. Pellets were not collected systematically or with an even distribution between sites and years.

Individual prey items were identified to species, when possible, in each pellet and counted separately. Prey item identification and keying was completed under contract by Ms. Rita Claremont, Corvallis, Oregon. Thomomys (bottae or mazama), woodrat (cinerea or fiscipes) and some Microtus species could not be keyed to species because the pellets lacked an intact skull necessary for identification. Because each prey item was counted separately the prey count may be overestimated as larger prey items can be contained in more than one pellet. Other studies (Forsman *et al.*, 2004) have combined pellets collected under the same roost or nest tree on the same day so as to decrease the likelihood of over counting prey items. During our collection of pellets we did not distinguish between pellets that were collected under the same roost or nest so prey items were not combined.

An analysis of pellets was completed using biomass of species, which is the count of individual prey items times the mean weight (grams). Mean weights were obtained from “Diets and Foraging behavior of Northern Spotted Owls in Oregon” (Forsman *et al.*, 2004). Weights for Lagomorph (rabbit) species were estimated because this prey item was represented in our samples by juveniles and sub-adults and biomass may have been overestimated using mean weight. Some prey items that could not be keyed to species (Microtus, Bird, and Muridae) had a large range of mean weights within each species so weight was also estimated for these.

4.0 Results

A total of 224 pellets were collected at 20 spotted owl activity centers between 1996 and 2004. There were 339 individual prey items identified or 1.5 prey items in each pellet (Table 1). Since pellets were collected non-systematically the distribution within this sample varies significantly between sites (Table 1) (Figure 2). As an example, a total of 7 owl activity centers account for 282 prey items or 83% of the entire sample.

The 339 individual prey items consisted of 330 mammals, 8 birds and 1 insect. There were 16 individual species of mammals, 5 species of birds, and 1 species of insect (Table 2). The mean weight of prey items was 163.0 grams (SE +/- 5.8 grams). Major prey species with greater than 1% of the total biomass included: woodrat sp. (58.3%), Northern flying squirrel (29.2%), broad-footed mole (3.9%), rabbit (3.9%) and gopher (1.4%) (Figure 3).

Woodrat sp. and Northern flying squirrels made up the majority of the total individual prey items and of the total biomass. Of the individual prey items Northern flying squirrel accounted for 36.6% and woodrat sp. 33.3%. Based on the biomass of each species the Northern flying squirrel accounted for 29.2% of the biomass and woodrat sp. 58.3% (Table 2). In total, woodrat sp. and Northern flying squirrels accounted for 70% of the individual prey items and 88% of the total biomass (Figure 3).

Figure 3 **Percent Biomass by Individual Prey Species for Total Population**
n = 339

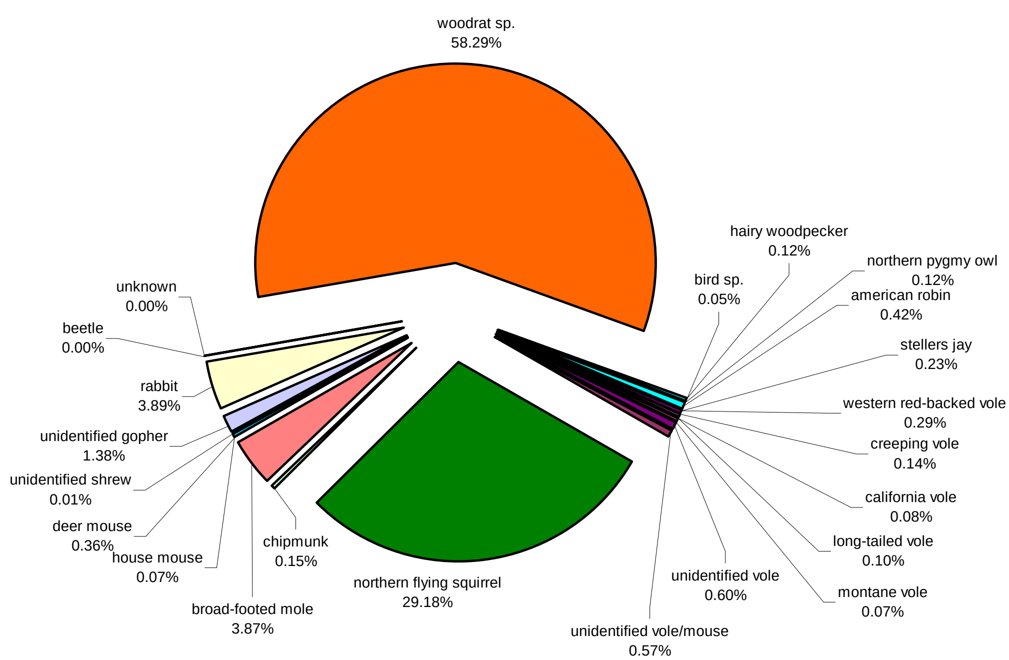


Table 1 Number of Pellets and Individual Prey items identified by site

Site Number	Site Name	Number of Pellets	Number of Individual Prey Items	Percent of Prey Items (%)
SK012	KC Mine	1	2	0.6
SK048	Collins Creek	6	7	2.1
SK051	Gumboot	13	18	5.3
SK052	Coats Creek	1	2	0.6
SK056	Kangaroo Creek	16	30	8.8
SK063	Singleton Creek	1	2	0.6
SK152	Stove Springs	1	1	0.3
SK302	Ikes Creek	20	25	7.4
SK310	Upper Bear Creek	6	7	2.1
SK340	Mckinney Creek	2	5	1.5
SK364	N. Fk. Ditch Creek	4	7	2.1
SK391	Deadwood	41	64	18.9
SK467	Ditch Creek	2	2	0.6
SK493	Negro Creek	5	6	1.8
SK541	Hells Canyon	8	18	5.3
SK542	Steep Trail	6	10	2.9
SK549	Golden Age Mine	38	57	16.8
SK553	Greenhorn/Mill	49	70	20.6
SK556	Barkhouse	1	1	0.3
TR061	Dan Rice Creek	3	5	1.5
	TOTAL	**224**	**339**	**100**

Table 2. Individual Prey Count and Biomass for the Total Population

Common Name	Total count of individual species	Mean mass of species (grams)	Total biomass (grams)	Percent Biomass (%)
American robin	3	77	231	0.42
Beetle sp	1	2	2	0.00
Bird sp	1	10	10	0.02
Bird sp	1	20	20	0.04
Broad-footed mole	31	69	2139	3.87
California vole	1	43	43	0.08
Chipmunk	1	83	83	0.15
Creeping vole	4	20	80	0.14
Deer mouse	9	22	198	0.36
Hairy woodpecker	1	66	66	0.12
House mouse	2	20	40	0.07
Long-tailed vole	1	56	56	0.10
Montane vole	1	40	40	0.07
Northern flying squirrel	124	130	16120	29.18
Northern pygmy owl	1	68	68	0.12
Rabbit	1	350	350	0.63
Rabbit	2	500	1000	1.81
Rabbit	1	800	800	1.45
Stellers jay	1	128	128	0.23
Unidentified gopher	8	95	760	1.38
Unidentified shrew	1	7	7	0.01
Unidentified vole	3	30	90	0.16
Unidentified vole	6	40	240	0.43
Unidentified vole/mouse	2	20	40	0.07
Unidentified vole/mouse	11	25	275	0.50
Western red-backed vole	7	23	161	0.29
Woodrat sp	113	285	32205	58.29
Unknown mammal	1	0	0	0
Total	**339**	**--**	**55252**	**100**

*Individual prey items in which mean weights were estimated are separated by weights in the table.

Twelve other mammal prey species represented 27% of the prey items and only 11% of the total biomass. These prey species included voles (Clethrionomys californicus, Microtus oregoni, Microtus sp, Muridae sp, Microtus montanus, Microtus longicaudus), mice (Mus musculus, Peromyscus maniculatus, Muridae sp), moles (Scapanus latimanus), gophers (Thomomys sp), and rabbit (lagomorph sp). Apparently minor prey species including two mammals, five birds species and one insect species represented 3% of the prey items and only 1% of the total biomass (Figure 3).

Further analysis of prey items by year to determine any annual variations in prey species was not completed. Pellets were not collected systematically with an even distribution between sites or years. Annual variation in the number individual prey items identified ranged from 1996 (n=1), 1997 (n=12), 1998 (n=57), 1999 (n=7), 2000 (n=12), 2001 (n=11), 2002 (n=6), 2003 (n=74) and 2004 (n=159). To complete an analysis of annual variation, similar owl diet studies have recommended having a minimum of 20 prey items each year for each site for 2 or more years (Forsman *et al*, 2004). Our relatively small sample size does not meet this criteria.

4.1 Differences between Klamath and Southern Cascades Provinces

Sample size in each province may influence any comparisons between provinces. A total of 184 pellets in the sample were collected from the Klamath mountains, which had 279 individual prey items identified (Table 3). Forty pellets were collected from the Southern Cascade with a total of 60 individual prey items (Table 3)(Figure 4)(Figure 5). The difference between pellet counts is primarily due to survey intensity as well as total number of spotted owl activity centers within each province. The Klamath Mountains has 66 total activity centers on or adjacent to Timber Products Company Land, while there are only 16 in the Southern Cascades.

TABLE 3. Number of Pellets and Individual Prey Items Identified by Province

Province Name	Number of Spotted owl Territories	Number of Pellets	Number of Individual Prey Items	Percent of Prey Items (%)
Klamath mountains	15	184	279	82
Southern Cascades	5	40	60	18
Total	**20**	**224**	**339**	**100**

Figure 4 **Percent Biomass by Individual Prey Species for the Klamath Province**
n = 279

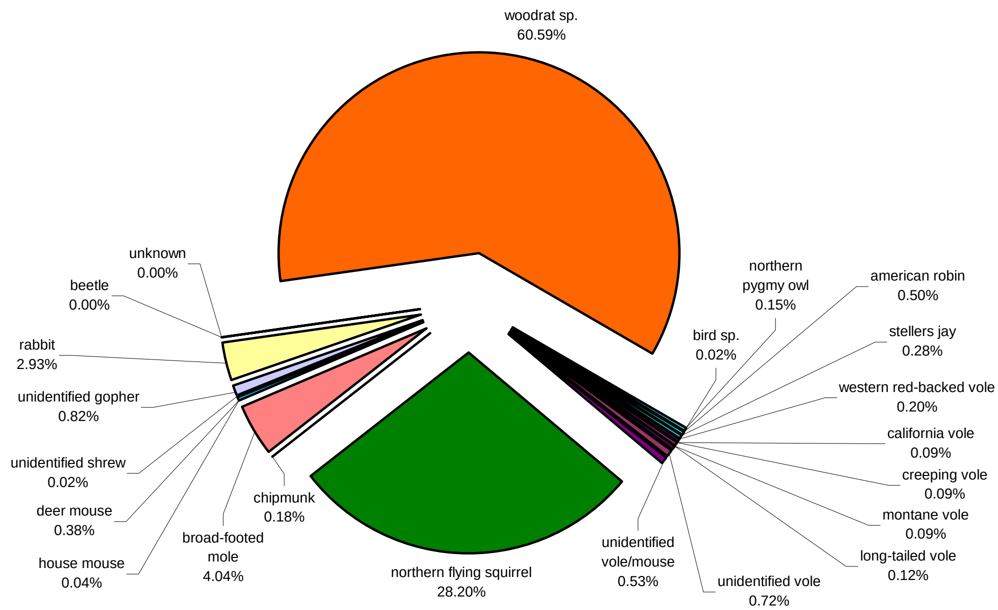
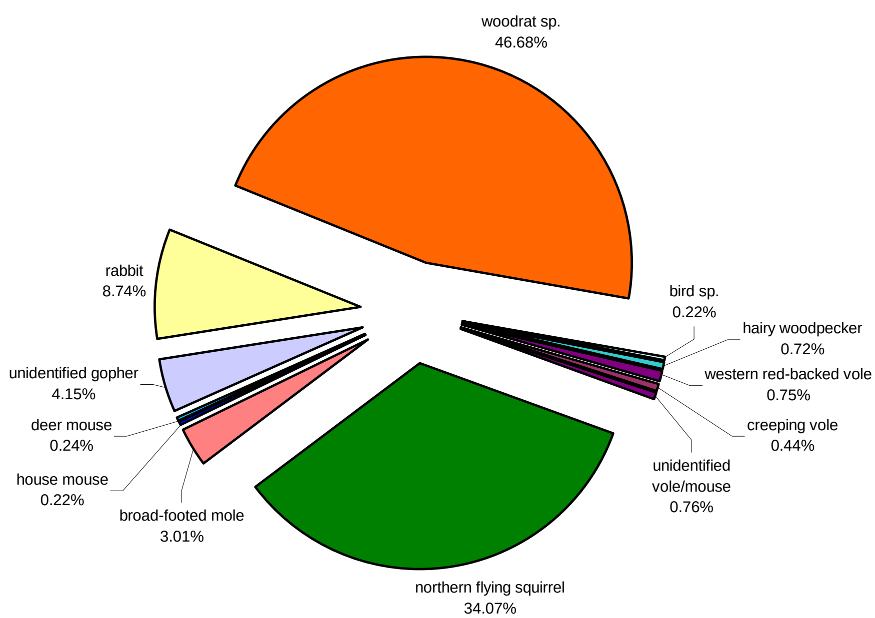


Figure 5 **Percent Biomass by Individual Prey Species for the Cascade Province**
n = 60



Both provinces were dominated by woodrats and Northern flying squirrels. In the Klamath mountains, woodrats comprised 61% of the total biomass and Northern flying squirrels were 28% (Table 3). The Southern Cascades had percentages of biomass for woodrats (47%) and Northern flying squirrels (34%) that were more evenly split. The difference in percentage of woodrats and Northern flying squirrels between provinces could be due to differences in vegetation, climate, sample size or that 42% of the prey items identified in the Southern Cascades came from one site (SK302, Ikes Creek).

Secondary prey items differed slightly between the Klamath mountains and Southern Cascades. In the Klamath mountains, secondary prey biomass included broad-footed moles (4%), rabbits (3%), voles (1%), gophers (1%), birds (1%), and mice (1%) (Table 4). In the Southern Cascades rabbits (9%), gophers (4%), moles (3%), voles (1%), birds (1%) and mice (1%) made up the secondary prey biomass for the province (Table 4). Secondary prey species seem to have slightly more significance in the overall diet composition of the owls in the Southern Cascades as secondary prey species make up 35% of the biomass (Table 4) (Figure 5). As opposed to the Klamath mountains where 11% of the total biomass are taken up by secondary species (Table 4) (Figure 4).

TABLE 4. **Differences in Percent Individual Prey Count and Biomass between the Klamath mountains and Southern Cascade Provinces**

Common Name	Klamath mountains Province: Percent of individual species (n = 279)	Klamath mountains Province: Percent Biomass (n = 46094g)	Southern Cascade Province: Percent of individual species (n = 60)	Southern Cascade Province: Percent Biomass (n = 9158g)
American robin	1.08	0.05		
Beetle sp	0.36	0.00		
Bird sp	0.36	0.02		
Bird sp			1.67	0.22
Broad-footed mole	9.68	4.04	6.67	3.01
California vole	0.36	0.09		
Chipmunk	0.36	0.18		
Creeping vole	0.27	0.09	3.33	0.44
Deer mouse	2.87	0.38	1.67	0.24
Hairy woodpecker			1.67	0.72
House mouse	0.36	0.04	1.67	0.22
Long-tailed vole	0.36	0.36		
Montane vole	0.36	0.09		
Northern flying squirrel	35.84	28.20	40.00	34.07
Northern pygmy owl	0.36	0.15		
Rabbit	0.36	0.63		
Rabbit	0.72	1.81		
Rabbit			1.67	8.74
Stellers jay	0.36	0.28		
Unidentified gopher	1.43	0.82	6.67	4.15
Unidentified shrew	0.36	0.02		
Unidentified vole	1.08	0.20		
Unidentified vole	2.15	0.55		
Unidentified vole/mouse	0.36	0.04	1.67	0.22
Unidentified vole/mouse	3.23	0.49	3.33	0.55
Western red-backed vole	1.43	0.20	5.00	0.75
Woodrat sp	35.13	60.59	25.00	46.68
Unknown mammal	0.36	0		
Total	**100**	**100**	**100**	**100**

*Individual prey items in which mean weights were estimated are separated by weights in the table.

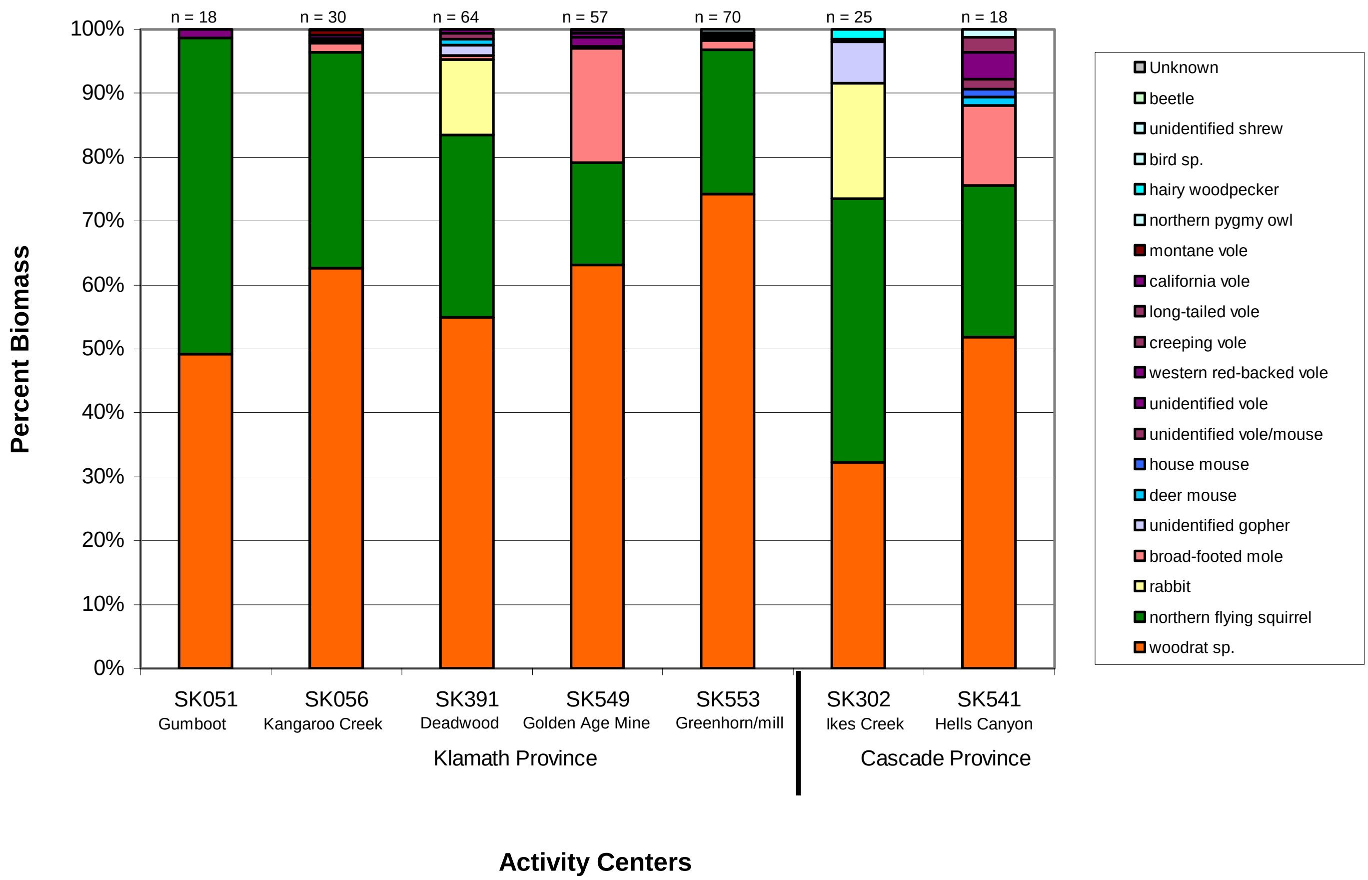
4.2 Variations by Habitat

To better understand relationships between prey items and habitats, the percent biomass by prey species within owl sites was compared to habitats found within the same owl sites. Since pellets were collected opportunistically there is a non-normal distribution of pellets within this study (Figure 2). To determine which owl sites had an adequate sample size for further habitat analysis our samples were compared with similar studies which have used $\geq$ 20 prey items per site (Forsman *et al*., 2004, Smith et. al, 1999) or $\geq$ 10 prey items per site (Forsman et. al., 2004) on estimates of means and overall diet composition. Based on our distribution of prey items by owl site and results from other similar studies it was determined that owl sites with 18 or more prey items would be used for this habitat analysis.

A total of 7 owl sites had 18 or more prey items. Of the total 339 prey items identified in the 20 sites, 282 prey items or 83% came from these 7 owl sites (five in the Klamath mountains and two in the Southern Cascades). The 282 prey items represent 85% or 47,315 grams of the total biomass. We examined this subset of the total sample to see if it was representative of the total sample. In the total sample woodrats accounted for 58% and Northern flying squirrels 28% of the biomass (Figure 3). In the subset sample, woodrats accounted for 60% and Northern flying squirrels 27% of the biomass. This subset appears to be representative of the total sample.

We found relatively minor differences in the distribution of individual prey items between owl sites. We compared the percent biomass between woodrats and Northern flying squirrels between owl sites. In the Klamath mountains woodrats percent biomass ranged from 49% (SK051) to 74% (SK553) and Northern flying squirrels percent biomass ranged from 16% (SK051) to 49% (SK549) (Figure 6). In the Southern Cascades woodrats were 32% (SK302) and 52% (SK541) of the biomass and Northern Flying Squirrels were 41% (SK302) and 24% (SK541) of the total biomass by owl site (Figure 6). Although the biomass percentages varied by site, both woodrats and Northern flying squirrels were important components in the diet at every owl site. There was no divergence between sites, meaning no one owl site contained the entire total biomass for either Northern flying squirrels or for woodrats.

Figure 6 Percent Biomass by Sites with ≥ 18 Individual Prey Items (n = total individual prey items)



Further analysis was completed to determine if any habitat associations occur between the seven owl sites. A regression analysis was completed to determine which species were normally distributed and could be used for further analysis. Through this analysis the woodrats sp. and Northern flying squirrels had adequate sampling to complete further analysis. To simulate owl foraging area the amount of each habitat type was calculated within a 0.7 mile circle (980 acres) around each of the seven owl sites. Based on radio telemetry results from owls located in both the Klamath and Southern Cascades provinces 75% of night time foraging locations are within 591 acre core use areas (Irwin *et al*, 2004). The habitats within the 0.7 mile circle came from a Geographic Information System (GIS) coverage that has been verified through a combination of aerial photographs, field verifications and forest inventory plot data.

A series of *a priori* hypothesis were made based on our current scientific understanding of woodrat and flying squirrel biology and life requisites. These questions intentionally limited the number of independent variables that were examined. We made these *a priori* hypothesis due to our limited sample size (n=7). It was our intention to verify other published results and not necessarily make any new associations with our limited sample size. The complete list of *a priori* hypothesis which may influence these species are listed in Table 5. In general, for Northern flying squirrels we examined the amount of large, dense conifer stands in relation to the percent prey biomass. We also examined the amount of Douglas-fir stands which support mistletoe and fungi which are reported to provide food for the species. We also examined the potential influence of elevation in determining the percent prey biomass. For woodrats we examined the amount of Ponderosa pine stands and sparse and open stands known to support woodrat den sites. Based on published studies we also examined the potential influence of elevation in determining the percent prey species biomass.

4.2.1 Flying Squirrels

A total of 14 *priori hypotheses* were examined (Table 6). To test these *a priori* hypothesis a step-wise logistical regression of 14 independent variables was calculated using PC Minitab (Minitab Inc.). None of the 14 independent variables were significant ($p<0.05$) at predicting percent flying squirrel biomass (dependent variable). Due to our relatively small sample size several independent variables demonstrated positive correlations (i.e. positive coefficients) with the percent flying squirrel biomass but were not significant. The amount of WHR size class 6 (i.e. old growth) (R2 = 0.45, $p<0.1$), amount of WHR size class 4, 5 and 6 (R2 = 0.28, $p>0.1$), percent of white fir habitat (R2 = 0.20, $p>0.1$) and elevation (R2 = 0.13, $p>0.1$) for the 0.7 mile circle. Also several independent variables demonstrated negative correlations (i.e. negative coefficients) with the percent flying squirrel biomass but were not significant. The amount of WHR size class 0 through 3 (R2 = 0.27, $p>0.1$) and the amount of non-conifer (R2 0.18, $p>0.1$) within the 0.7 mile circle.

4.2.2 Woodrats

A total of 14 *a priori* hypotheses were also examined for woodrats (Table 5). To test these *a priori* hypothesis a step-wise logistical regression of 14 independent variables was also calculated using PC Minitab (Minitab Inc.). Only one of the 14 independent variables was significant ($p<0.05$) at predicting percent woodrat biomass. The percent of Ponderosa pine habitat within a 0.7 mile circle was significant ($p<0.05$) at predicting the percent of woodrat biomass for the owl site (Figure 7). Due to our relatively small sample size one additional independent variable demonstrated positive correlations (i.e. positive coefficient) with the percent woodrat biomass but was not significant. The percent of Douglas-fir habitat (R2 = 0.13, $p>0.1$) within the 0.7 mile circle. Also several independent variables demonstrated negative correlations (i.e. negative coefficients) with the percent woodrat biomass but were not significant. The amount of white fir habitat (R2 = .18, $p>0.1$) within the 0.7 mile circle. Also, elevation of the owl site was negatively correlated with the percent of woodrat biomass for the site (R2 = 0.23, $p>0.1$) but was not significant (Figure 8).

Due to statistical results from the step-wise logistical regressions one model was constructed to predict the percent of woodrat biomass for the site. The percent of Ponderosa pine habitat was added to the percent of Douglas-fir habitat within a 0.7 mile circle which was significant (R2 = 0.85, $p<0.05$) at predicting the percent of woodrat biomass for the site (Table 5).

Table 5 Regression of 14 Independent variables

Dependent Variable	Independent Variable	n	R^2	Coefficient (+ or -)	Significance
% F. Squirrel Biomass	% KMC	7	0.052	+	$p > 0.1$
	% PPN	7	0.078	-	$p > 0.1$
	% DFR	7	0.130	-	$p > 0.1$
	% WFR	7	0.203	+	$p > 0.1$
	% Non-Conifer	7	0.178	-	$p > 0.1$
	WHR Size 0 to 3	7	0.274	-	$p > 0.1$
	4 to 6	7	0.277	+	$p > 0.1$
	6	**7**	**0.451**	**+**	**$p < 0.1$**
	WHR Density 0,S,P	7	0.113	+	$p > 0.1$
	M & D	7	0.075	+	$p > 0.1$
	NSO NR & NRD	7	0.090	+	$p > 0.1$
	FOR & FORD	7	0.080	-	$p > 0.1$
	NON	7	0.072	-	$p > 0.1$
	Elevation	7	0.129	+	$p > 0.1$
% Woodrat Biomass	% KMC	7	0.146	-	$p > 0.1$
	% PPN	**7**	**0.531**	**+**	**$p < 0.05$**
	% DFR	7	0.131	+	$p > 0.1$
	% WFR	7	0.179	-	$p > 0.1$
	% Non-Conifer	7	0.001	+	$p > 0.1$
	WHR Size 0 to 3	7	0.029	+	$p > 0.1$
	4 to 6	7	0.036	-	$p > 0.1$
	6	7	0.001	-	$p > 0.1$
	WHR Density 0 & S & P	7	0.127	-	$p > 0.1$
	M & D	7	0.091	+	$p > 0.1$
	NSO NR & NRD	7	0.013	+	$p > 0.1$
	FOR & FORD	7	0.011	-	$p > 0.1$
	NON	7	0.010	-	$p > 0.1$
	Elevation	7	0.230	-	$p > 0.1$
	%PPN + % DFR	**7**	**0.847**	**+**	**$p < 0.05$**

Figure 7 Predicted Woodrat biomass from Percent Ponderosa Pine Type

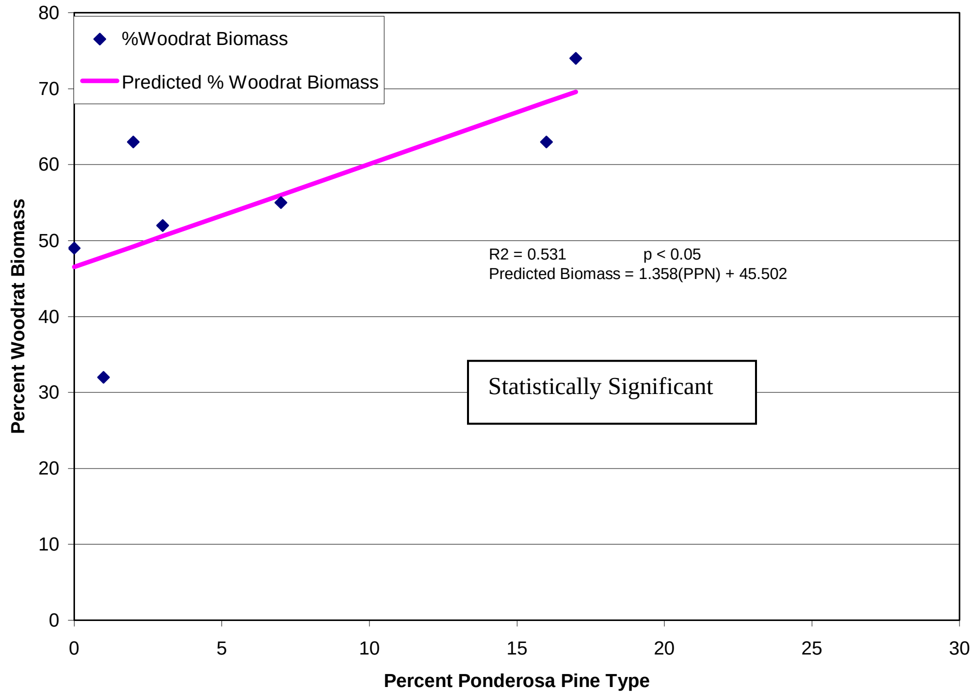
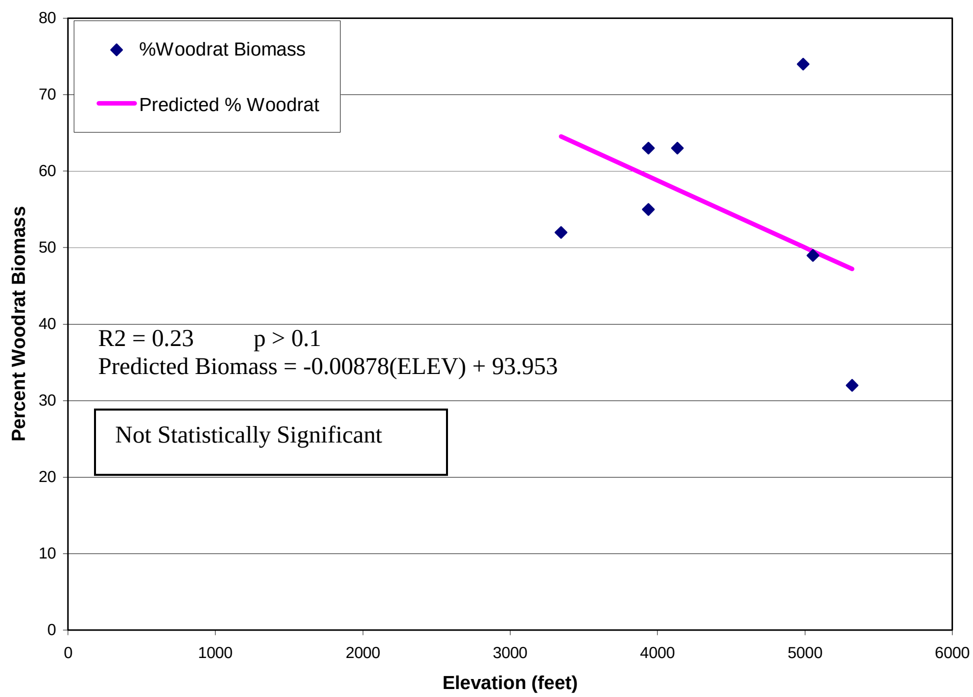


Figure 8 Predicted Woodrat biomass from Elevation (feet)



5.0 Discussion

Geographic Range of the Owl

Our results found that the primary prey species in the eastern Klamath Mountains and Southern Cascades are woodrat sp. and Northern flying squirrel. These two species account for 70% of the individual prey items and 88% of the total biomass in our study. These results are similar to the results of other studies in the Klamath mountains and Southern Cascades provinces of the owl (Forsman *et al*. 2004, Ward *et al*., 1998, Zabel *et al*., 1995, Munton *et al*., 2002). From north to south throughout the range of the spotted owl, Northern flying squirrels decrease while woodrats increase in importance in the diet of the owl (Thomas *et. al*. 1990). To the north in the Klamath Mountains of Oregon (interior southwest) Forsman *et al*., (2004) found that woodrats were the main prey item (49% of the total biomass) although Northern flying squirrels were also important in terms of biomass (30% of the total biomass). To the south in the Sierra National Forest, Munton *et al*., (2002) had similar results, in that Northern flying squirrels were dominant in coniferous forests (45% of the total biomass) while woodrats were the main prey species (74% of the total biomass) in low-elevation oak savannas, oak/foothill pine forests, and riparian-deciduous forests. Our results confirmed that Timber Products Company forestlands lie in the portion of the range where both prey species are important to the survival and reproduction of the owl (Forsman *et al*. 2004).

Our mean biomass of 163.0 grams (SE +/- 5.8 grams) also appears to be similar to results of other studies in the Klamath mountains and Southern Cascades provinces of the owl. Forsman *et al*., (2004), found in Oregon that more northern or coastal provinces mean biomass was lower ranging from 90.7 grams to 123.6 grams. While, mean biomass was higher in Oregon's southern coastal region (131.4 grams) and in the interior southwest province (142.1 grams) that is adjacent to our study area. Also, studies of radio telemetry owls in the Klamath mountains province found significantly smaller owl home ranges for sites with higher mean prey biomass (Zabel *et al*., 1995). Based on our results it appears that in the Klamath mountains and Southern Cascades owls benefit from availability of larger prey items which may explain relatively smaller home range sizes found in local owl telemetry studies (Irwin *et al*., 2004).

Southern Cascades versus Klamath Province

There appears to be a small difference between the Klamath mountains and Southern Cascades provinces in our study. The amount of woodrat biomass appears to be higher in the Klamath mountains as compared to the Southern Cascades. However, a potential sampling bias in our field data collection (i.e. n=279 Klamath Mountains vs. n=60 Southern Cascades) could be influencing this potential relationship. Examination of percent of woodrat and Northern flying squirrel biomass by each owl site indicates that the Klamath mountains and Southern Cascades owl sites cannot be separated within the total sample.

The influence of generally more open and drier habitats in the Southern Cascades than in the Klamath Mountains may be influencing a difference in secondary prey species. In the Southern Cascades rabbits and gopher comprise 12.8% of the biomass while only 3.7% in the Klamath mountains. These open habitat species may play an important role in the Southern Cascades in "replacing" or "substituting" for woodrat biomass.

Habitat Type and Elevation

Other studies have found that typically Northern flying squirrels are the predominate prey in higher elevation coniferous forests while woodrats make up the majority of prey in lower elevation oak woodlands (Munton *et al*., 2002). Our results appear to confirm this observation as our Ponderosa pine habitats were significant ($p<0.05$) at predicting woodrat biomass. While not significant, other results indicate that Northern flying squirrels are correlated with higher elevation habitats like white fir and negatively correlated with lower elevation non-conifer habitats like open oak woodland and grasses.

Munton *et al*., (2002) also found that the primary prey species at higher elevations (>4000 feet) was flying squirrels while woodrats were at lower elevations (<4000 feet). While not significant our results examining elevation also found that woodrat biomass was greater at lower elevations than at higher elevations. Our results suggest that flying squirrels may be the primary prey species at owl sites above 5,000 feet that are dominated white fir habitats. Our results also suggest that woodrats may be the primary prey species at owl sites below 5,000 feet that are dominated by Ponderosa pine and Douglas-fir habitats. The difference in elevation (5,000 feet vs. 4,000 feet) may be explained by the relatively high elevations of our conifer forests and owl sites which are some the highest recorded owl nest sites in the range of the species (Farber and Crans, 2000).

Habitat Tree Size and Density

Similar to other studies we did not find significant differences in the size or amount of large trees or density of stands (canopy closure) between sites to predict percent biomass of woodrats or flying squirrels (Zabel et al., 1995). Our results also indicate that owl diets consist of a variety of prey items with woodrat sp. and Northern flying squirrel being the dominant prey item. However, due to our relative small sample size (n=7) we had several tree size independent variables that were modestly correlated with flying squirrels but were not significant. We also had several tree density independent variables that were modestly correlated (negative coefficient) with flying squirrels but were not significant. Our results indicate that maintaining a variety of habitats for both woodrat sp. and Northern flying squirrel within owl sites maybe beneficial for foraging Northern spotted owls.

6.0 Conclusions

1) Northern spotted owls consume a wide variety of prey including 16 individual species of mammals, 5 species of birds, and 1 species of insect.

2) Based on 339 individual prey items, woodrat sp. and Northern flying squirrel represented 70% of the individual prey items and 88% of the biomass in our study.

3) Mean biomass of 163.0 grams (SE+/- 5.8 grams) appears to be similar to results of another study in the interior southwest province of Oregon (142.1, SE +/- 5.0 grams).

4) Woodrat sp.(60.6%) followed by Northern flying squirrel (28.2%) biomass were the primary prey species for Northern spotted owls in the Klamath mountains.

5) Woodrat sp. (46.6%) followed by Northern flying squirrel (34.1%) biomass were the primary prey species of Northern spotted owls in the Southern Cascades.

6) No independent variables including tree species, size or density were significant at predicting the percent of Flying squirrel biomass for an owl site.

7) The percent of Ponderosa pine habitat within a 0.7 mile circle was significant ($R2=0.53$, $p<0.05$) at predicting the percent of woodrat biomass for an owl site.

8) Results of a step-wise logistical regression constructed a model where the percent of Ponderosa pine and Douglas-fir habitat within a 0.7 mile circle was significant ($R2=0.85$, $p<0.05$) at predicting the percent of woodrat biomass for an owl site.

9) While not statistically significant, elevation may be negatively associated with the percent of woodrat biomass and positively associated the percent Northern flying squirrel biomass for an owl site.

10) Our results indicate that owl diets consist of a variety of prey items. Habitat associations with each prey species indicate that maintaining a variety of habitats within owl sites maybe be beneficial for foraging Northern spotted owls.

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Habitat Relations

Habitat Selection by Northern Spotted Owls in Mixed-Coniferous Forests

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ABSTRACT Conservation planning for the federally threatened northern spotted owl (*Strix occidentalis caurina*) requires an ability to predict their responses to existing and future habitat conditions. To inform such planning we modeled habitat selection by northern spotted owls based upon fine-scale (approx. 1.0 ha) characteristics within stands comprised primarily of mixed-aged, mixed coniferous forests of southwestern Oregon and north-central California. We sampled nocturnal (i.e., primarily foraging) habitat use by 71 radio-tagged spotted owls over 5 yr in 3 study areas and sampled vegetative and physical environmental conditions at inventory plots within 95% utilization distributions of each bird. We compared conditions at available forest patches, represented by the inventory plots, with those at patches used by owls using discrete-choice regressions, the coefficients from which were used to construct exponential resource selection functions (RSFs) for each study area and for all 3 areas combined. Cross-validation testing indicated that the combined RSF was reasonably robust to local variation in habitat availability. The relative probability that a fine-scale patch was selected decreased nonlinearly with distances from nests and streams; varied unimodally with increasing average diameter of coniferous trees and also with increasing basal area of Douglas-fir (*Pseudotsuga menziesii*) trees; increased linearly with increasing basal areas of sugar pine (*Pinus lambertiana*) and hardwood trees and with increasing density of understory shrubs. Large-diameter trees (>66 cm) appeared important <400 m from nest sites. The RSF can support comparative risk assessments of the short- versus long-term effects of silvicultural alternatives designed to integrate forest ecosystem restoration and habitat improvement for northern spotted owls. Results suggest fine-scale factors may influence population fitness among spotted owls.

KEY WORDS discrete choice, habitat selection, mixed-coniferous forests, northern spotted owl, resource selection function, risk assessment, RSF, *Strix occidentalis caurina.*

Public forest and resource managers in the western United States are seriously challenged to recover wildlife listed under the United States' Endangered Species Act of 1973 while concomitantly addressing economic interests, climate-change concerns, and forest-health problems. Private timberland managers are equally challenged with producing wood products and fiber sustainably while meeting environmental goals such as avoiding incidental take, a legal term for harming, harassing, or killing listed species incidental to otherwise legal activities. No other federally listed wildlife species exemplifies such dilemmas more than the threatened northern spotted owl because it is closely associated with economically- and ecologically valuable late-successional and old-growth forests, many of which are considered at risk to devastating wildfires and epidemics of insects and forest diseases (United States Fish and Wildlife Service 2008).

An early conservation strategy for the northern spotted owl (Thomas et al. 1990) recommended development and testing of silvicultural prescriptions that might enhance existing habitats in the short term (<5 yr) or produce new habitats over the long run (>50 yr). The latest recovery plan for the northern spotted owl (United States Fish and Wildlife Service 2008) proposed a strategy for dry forest landscapes of the eastern and southern Cascades Mountains that would employ silvicultural prescriptions to reduce fuel loads and restore more-natural ecosystem patterns and processes over the long term. Before potential silvicultural prescriptions are widely applied for such purposes, there is first a need to understand how spotted owls are likely to respond. This is particularly true for treatments that might target specific tree size-classes for removal or retention, reduce forest density, or modify tree species composition, such as to favor fire-adapted or shade-intolerant species.

Unfortunately, scant information exists to support comparative risk- versus benefit assessments of the short- and long-term consequences to northern spotted owls from implementing, or not implementing, ecologically motivated silvicultural treatments. This is especially true for relatively dry mixed-age, mixed-coniferous forests that occur in the

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eastern Cascades Mountains of Washington and Oregon and the southern Cascades of northern California, where spotted owl–habitat relationships remain poorly documented. Irwin et al. (2007) developed a resource selection function (RSF) that could be linked with forest vegetation simulators or wildfire-risk models within a risk-assessment framework for mixed-coniferous forests occupied by the California spotted owl (*S. o. occidentalis*), and Roloff et al. (2005) used extant literature and an unpublished model to compare short- and long-term risks to spotted owl habitat from large, intensive wildfires in the southern Oregon Cascades. However, owl–habitat relationships may differ between the 2 subspecies and robust models are needed that incorporate silviculturally induced changes in tree species composition and density, as well as associated changes in understory vegetation. Predictive modeling of spotted owl responses to vegetative conditions at scales ranging from individual home ranges to the population level will assist in conservation and recovery planning.

Scale of an investigation plays a critical role in determining patterns of habitat selection (Johnson 1980, Karl et al. 2000). Previous investigations of habitat selection by northern spotted owls compared amounts of used versus available seral stages, age classes, or cover types at the scale of forest stands within annual home ranges (e.g., Forsman et al. 1984, Lehmkuhl and Raphael 1993, Glenn et al. 2004) or across landscapes (Meyer et al. 1998). Such categorical analyses included implicit assumptions that forest stands were relatively homogeneous in structure and tree- and understory-species composition, and that space use by owls was evenly distributed within stands and across home ranges.

However, structure and composition often vary widely within seral stages (Spies and Franklin 1991), and classification of forest stands according to successional stages can be ambiguous by collapsing such variation. Moreover, as central-place foragers (Carey and Peeler 1995, Rosenberg and McKelvey 1999), spotted owls do not use their home ranges evenly (Bingham and Noon 1997). Further, vegetation classifications based upon even-aged concepts may not apply in mixed coniferous forests where frequent disturbances and previous timber harvesting created multi-aged cohorts within stands (Camp 1999, Taylor and Skinner 1998). Also, selective silviculture and forest-fuel reduction programs do not change seral stages; instead they modify heterogeneity by altering tree density and composition, tree size-class distribution, and understory vegetation, complicating seral-stage mapping. Lacking such details, seral-stage or cover-type classifications could mislead relative risk analyses that compare initial spotted owl responses to habitat modification with potential long-term responses to future forest conditions.

Zabel et al. (1992) recommended that researchers measure continuous fine-scale details such as basal area and tree density for evaluating responses by spotted owls to modifications of forest habitats. Indeed, northern spotted owls are capable of identifying and intensively using small patches within what otherwise would be classified and mapped as homogeneous stands or seral stages based on characteristics of predominant overstory trees (Buchanan et al. 1995; Carey and Peeler 1995; Irwin et al. 2000, 2007). Wildlife habitat selection and home range characteristics emerge from successive behavioral choices made at such small scales (Moorcroft and Lewis 2006). These choices may affect the balance of costs and benefits, such as tradeoffs between foraging and risk of being killed by a predator (Partridge 1978, Rosenzweig 1985). Foraging habitat selection and other nocturnal behaviors such as territory maintenance are assumed to influence lifetime reproductive performance and survival (Newton 1979). Fluctuations in reproduction and fledgling survival, in turn, are believed to drive annual variability and short-term population trends in spotted owl populations (Franklin et al. 2000, Seamans et al. 2001).

We investigated patch-scale habitat selection by northern spotted owls in dry, mixed-conifer forests to inform forest and wildlife resource managers and thereby contribute to integrated owl recovery and forest restoration. We quantified nocturnal habitat choices by individual northern spotted owls in relation to physical (i.e., abiotic) environmental factors and spatial variation in vegetation structure, density and composition resulting from natural disturbances and previous forestry practices (largely partial harvesting). Our goal was to construct and test RSFs linking data from forest-inventory plots with nocturnal locations of radio-tagged northern spotted owls occupying landscapes that represented a gradient from relatively less-intensively managed federal forests to more-intensively managed private industrial timberlands. Resource selection function (RSF) models have applications in cumulative effects analyses or risk assessments, forest landscape management planning, and population viability analyses (Boyce et al. 1994, Boyce and McDonald 1999, Aldridge and Boyce 2007). We wanted to use the RSFs to suggest silvicultural prescriptions for testing within an adaptive management framework and to inform relative risk assessments for larger scales. Thus, our objectives were: 1) identify factors associated with habitat selection by northern spotted owls in dry, mixed coniferous forests; 2) quantify vegetative and abiotic factors into a reliable RSF model that can predict selected patches within spotted owl home ranges; and 3) inform large-scale conservation and management strategies that account for owl habitat selection in mixed-conifer forests.

STUDY AREA

We identified 3 dry-forest study areas near Klamath Falls (KLAM) and Medford (MED), Oregon, and Yreka (YREK), California, USA (Fig. 1) at the interface of the Southern Cascades and Klamath Mountains Provinces of southwestern Oregon and north-central California. We chose these areas because land management agencies or private landowners had scheduled silvicultural activities in areas occupied by northern spotted owls and because they exhibited effects of a broad range of previous forest management activities. Elevations ranged from 600 m to 2,200 m above mean sea level. Forests primarily included those within the Mixed-Conifer, *Abies concolor* and *Abies magnifica shastensis* Zones (Franklin and Dyrness 1981, Sawyer 2007).

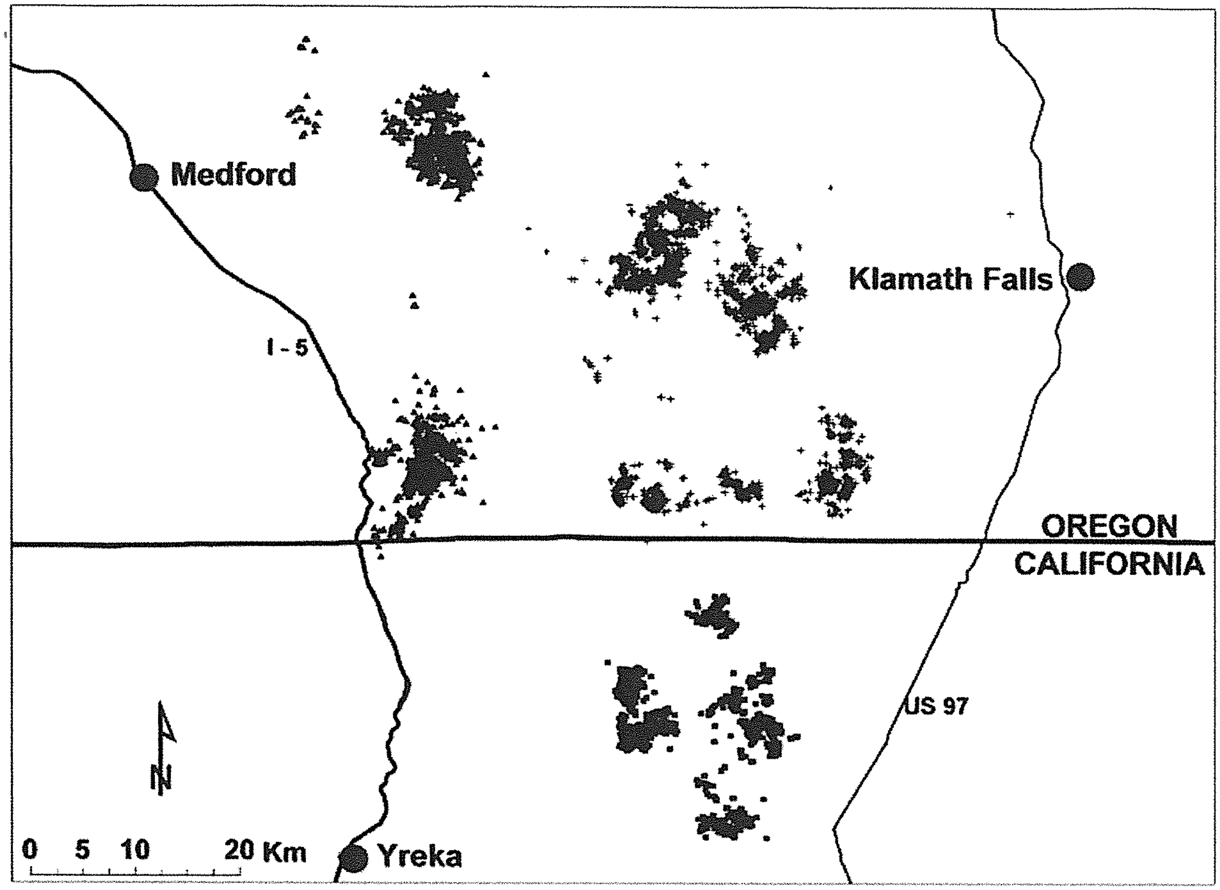

Figure 1. Study-area locations for evaluating foraging (nocturnal) habitat selection by radio-tagged northern spotted owls, including telemetry locations from 1998 to 2003 at Medford, Oregon (solid triangles), 2002–2006 at Klamath Falls, Oregon (pluses), and 1998–2003 at Yreka, California (solid squares), USA.

Mixed conifer forests, which predominated at mid- and lower elevations in our study areas, were shaped by long dry periods annually and by frequent wildfire disturbances that created multiple cohorts within stands (Taylor and Skinner 1998). Over the past century, many of these forests were also modified via selective harvesting, clearcutting and shelterwood harvesting, as well as fire suppression activities. Combined, these multiple factors and disturbances promoted highly variable forest landscapes comprised of heterogeneous mixtures that ranged from shrubfields, recent clearcuts and partially harvested stands, dense patches of mixed-age shade-tolerant trees such as white fir (*A. concolor*) and large remnant, shade-intolerant trees such as Ponderosa pine (*Pinus ponderosa*) and Douglas-fir (Skinner 1995) to multi-layered patches dominated by large, presumably old trees. Many forest stands were considered at-risk to extensive stand-replacing wildfires, particularly in conjunction with outbreaks of insects and forest diseases.

Major tree species included California red fir (*Abies magnifica)* or Shasta red fir (*A.m.* var *shastensis*) at the highest elevations, whereas mid- and lower elevations were comprised of Douglas-fir, sugar pine, ponderosa pine, incense cedar (*Libocedrus decurrens*), and white fir, with occasional California black oak (*Quercus kelloggii*), Oregon white oak (*Q. garryana*), and locally abundant bigleaf maple (*Acer macrophyllum*) and Pacific madrone (*Arbutus menziesii*). Important shrubs included golden chinquapin (*Castanopsis chrysophylla*), Pacific dogwood (*Cornus nuttallii*), canyon live oak (*Quercus chrysolepis*), creeping snowberry (*Symphoricarpos mollis*), various *Ceanothus* spp., and green manzanita (*Arctostaphylos patula*). The forests also were occupied by potential predators of spotted owls including northern goshawks (*Accipiter gentilis*) and great-horned owls (*Bubo virginianus*). During our study barred owls (*Strix varia*), a major competitor (Gutiérrez et al. 2007), were scarce compared to other regions in the range of northern spotted owls.

METHODS

Field Methods

Telemetry.—We collected data from 1998 to 2003 at MED and YREK, and from 2002 to 2006 at KLAM. Within these areas, we chose locations that had been occupied for ≥5 yr by spotted owl pairs that had exhibited successful reproduction prior to our study. Adult spotted owls were located and captured using accepted procedures and animal-welfare protocol (Forsman 1983). All captured birds were fitted with 7.5–8.0 g backpack harness transmitters (<1.5% adult owl body mass) and monitored for nesting attempts and reproductive success. Radio-tagged owls were recaptured and fitted with new transmitters biannually, or sooner if transmitters failed prematurely. Loehle et al. (2005) reported comparatively high survival rates (>0.90) for a widespread sample of radio-tagged owls that included those in this study. Foster et al. (1992) found that backpack-harness transmitters >19 g **reduced reproductive success among spotted owls,** consistent with effects of transmitters on birds in general (Barron et al. 2010). During our study, annual fecundity rates of owl pairs ranged from 0.0 to 0.35, but we had no unbiased means of determining whether the comparatively small transmitter-backpack units significantly influenced reproductive rates.

We recorded habitat use via standard radio-tracking methods described by Carey et al. (1989) and Millspaugh and Marzluff (2001). We sought to map the locations of each owl 2–3 nights per week each year to provide a reasonably large, temporally independent sample (Guetterman et al. 1991). We rotated the order of tracking weekly to create a range in nocturnal (i.e., 1 hr after sunset to 1 hr before sunrise) sampling times for each bird. We obtained transmitter signals using hand-held 3-element Yagi directional antennae (Wildlife Materials, Inc., Carbondale, IL or Telonics, Mesa, AZ). We triangulated positions of owls, which often remained motionless as sit-and-wait predators, from 3 azimuths recorded within 10–15 min from geo-referenced receiving stations along access roads, using methods similar to Glenn et al. (2004). Coordinates of receiving stations and telemetry locations were stored in a database using LOAS software (Ecological Software Solutions, LLC, Tallahassee, FL, USA). Extensive road systems helped mitigate many of the well-known radio-tracking problems by allowing field personnel to acquire most signals <400 m from owls. We mapped azimuths of signals in the field on 1:24,000 topographic maps. If a mapped triangulation polygon was >3 ha, we discarded the location and recorded another sample. We assessed the accuracy of our telemetry system by placing transmitters at locations <600 m from and unknown to radio-tracking crews. Average distance of 159 estimated locations to the true geo-referenced transmitter locations was 84 m (SE = 12 m), with a median value of 56 m, and 94% of the triangulations resulted in error polygons <1.0 ha.

Sampling available habitat conditions.—We defined a patch as a 1-ha unit that was more homogeneous with regard to tree- and understory-species composition and density, structures, and tree size than the stand within which it was embedded. To characterize such patches, we obtained forest inventory data from collaborating private landowners who inventoried their forests during the study period. Our field crews also inventoried associated federal timberlands shortly after we completed radio-tracking, using random-start assignment and the same methods as applied to private timberlands, which included an approximate density of 1 inventory plot/1.6 ha. Thus, the distribution of inventory plots was within the resolution of the telemetry system. Cooperators provided additional inventory information to update habitat conditions for areas where timber harvesting occurred during the study. We estimated available habitat conditions within cumulative individual 95% utilization distributions (1–1.5 yr), using program BIOTAS (Ecological Software Solutions, LLC). Following Irwin et al. (2007) we assigned habitat data to telemetry locations based upon the inventory plots, except that we discarded telemetry points ≥100 m from inventory plots (i.e., approx. mean telemetry error + 1 SE).

We identified variables to measure based on previous research involving factors influencing prey species (e.g., Carey 1991, 1995; Carey et al. 1992, Zabel et al. 1995, Carey and Harrington 2001, Anthony et al. 2003), habitat selection by spotted owls (e.g., Haufler and Irwin 1994, Glenn et al. 2004, Irwin et al. 2004, McDonald et al. 2006), or potential utility for silvicultural options (e.g., Irwin et al. 2007). These variables included vegetation characteristics, physical environmental factors, and map-based features. We used variable-radius plots (Bell and Dilworth 1990) to estimate several metrics of forest density: basal area, quadratic mean diameter (QMD; diam of a tree of average basal area), trees per hectare (TPH), tree density-by-diameter class, and stand-density index (SDI) by diameter class (Long 1985, Lilieholm et al. 1993). We counted shrub clumps, downed trees, and snags (>50 cm dbh) in 0.2-ha circular plots. We derived map-based features from a digital elevation model in a geographic information system (GIS).

Statistical Analyses

We employed a statistical method that permitted an examination of factors that could be scaled-up from patches used by a collection of individuals to predict how a spotted owl population might respond to variation in topography and vegetation conditions across a landscape. We chose the discrete-choice RSF (Manly et al. 2002, McDonald et al. 2006) as an estimating function and for its predictive value, not for statistical inference because statistical inference is not a particularly useful concept in habitat modeling (Boyce et al. 2002). Discrete-choice models can account for habitat changes that occur during a study (e.g., logging or wildfires), and allow comparisons among used resource units, or covariates of the resource units, with those available (described as choice sets) within individual home ranges.

Classic discrete-choice models assume that when a choice is made from each of several sets of units, a new random sample of available units is taken (Manly et al. 2002: 162), but McDonald et al. (2006) showed that a simplified discrete-choice model based upon a single random sample of available units yields valid results. If the choices are independent and data are available for all units that may be selected, then the classic discrete-choice model can be applied because it is not necessary that the choice set change for each selection (McDonald et al. 2006). Therefore, we acquired a single random-start sample of available habitat choices (i.e., choice sets) within home-range sized units. We developed new choice sets after timber harvesting (usually thinning from below) changed habitat conditions within home ranges.

The methods of analyses and model construction that we adopted have been applied in previous spotted owl studies (McDonald et al. 2006, Irwin et al. 2007). Briefly, we accounted for variation in habitat availability within home ranges and during the study period by developing choice sets

Table 1. Abbreviations and descriptions of variables used in candidate models to characterize habitat selection by northern spotted owls in southwestern Oregon and northern California, USA, 1998–2006.

Variable	Definition and unit	Abbreviation
Basal area	**Cross-sectional area of all stems in a stand measured at breast height (m^2/ha)**	**BA**
Douglas-fir BA	Basal area occupied by Douglas-fir trees >12.7 cm dbh	BADFIR
Ponderosa pine BA	Basal area occupied by ponderosa pine trees >12.7 cm dbh	BAPPIN
Sugar pine BA	Basal area occupied by sugar pine trees >12.7 cm dbh	BASUG
White fir BA	Basal area occupied by white fir trees >12.7 cm dbh	BAWFIR
Incense cedar BA	Basal area occupied by incense cedar >12.7 cm dbh	BAINCED
Red fir BA	Basal area occupied by red fir >12.7 cm dbh	BARFIR
Hardwood BA	Basal area occupied by hardwood species >12.7 cm dbh	BAHDW
Quadratic mean diam	Diam of tree corresponding to average basal area of a stand of trees (cm)	QMD
Stand density index	**Combination of density and size [TPH(dbh/10)$^{1.77}$]**	**SDI**
Trees/hectare	Total number of trees/ha >12.7 cm dbh in a stand	TPH
Size class	**Density or basal area of live trees of specified size groups (e.g., $TPH_{\geq 13}$ is density of trees ≥13 cm dbh; $BA_{\geq 66}$ is basal area of trees ≥66 cm dbh**	**$BASAL_{xxx}$ or TPH_{xx}**
Large snags	**No. of snags ≥66 cm dbh and >1.8 m tall**	**SNAG**
Shrub count	Number of shrubs counted in a 0.2-ha plot	SHRUB
Downed woody debris	**Number of large downed logs (≥66 cm) per 0.2-ha plot**	**DWD**
Distance to streams	Distance (m) from telemetry or random point to nearest permanent stream	STREAM
Elevation	Elevation of point (m) above mean sea level	ELEV
Roads	Distance (m) to nearest traveled road	ROAD
Nest	Distance (m) to nesting site or center of activity	NEST
Slope	Angle of slope, in degrees	SLOPE
Heatload	**Expression of slope and aspect effects, calculated as tan(SLOPE) × sin(ASPECT) + tan(SLOPE) × cos(ASPECT), following Stage (1976)**	**HEATLOAD**

circumscribed by 95% contours of the utilization distributions of individual radio-tagged spotted owls. Use of a 95% contour to define the template of availability is objective, repeatable, and consistent with home range studies for many species (White and Garrott 1990, Bingham and Noon 1997). Although home ranges of mated pairs have a high degree of overlap (Forsman et al. 1984), males and females hunt independently for prey. We did not assume uniform distribution within the zone of availability. In fact, by including map-based covariates (e.g., distance from nest sites), we explicitly accounted for non-uniform spatial patterns of distribution of use within home ranges. Utilization sets encompassed habitat choices made during 1- to 1.5-yr periods of telemetry-point acquisition for individual owls. This was done to ensure that the owls used a small proportion of the available units (Manly et al. 2002), thereby minimizing statistical contamination of the available units (Johnson et al. 2006). We compared vegetative habitat and physical **environmental covariates (Table 1) for used locations** (i.e., utilization sets) with samples of conditions at available forest inventory points within home ranges (i.e., choice sets).

We used a stratified Cox proportional hazards model in S-PLUS 8.1 (Tibco Software, Inc., Palo Alto, CA) as an approximating function to obtain estimates of coefficients for variables to include in exponential RSF models for each study area and for all study areas combined following McDonald et al. (2006),

$$w(x_i) = \exp(\beta_1 x_1 + \ldots + \beta_i x_i) \quad (1)$$

where $w(x_i)$ **is the relative probability of selection given the set of independent variables,** $x_1 - x_i$.

We assigned used locations (telemetry points) a value of 1 and available locations (inventory plots) a value of 2 (Manly et al. 2002:208, McDonald et al. 2006). Each 1.0- to 1.5-year sample of used locations and corresponding sample of inventory plots (or choice set) comprised a stratum in the model. Strata are similar to the way that blocking factors control nuisance variation in analysis of variance (ANOVA). The stratified Cox proportional hazards model thereby accounts for potential variation among individuals and years, although it does not provide coefficients for strata.

Adhering to the principle of parsimony, we limited the number of models considered by proceeding in stages and by depending upon existing knowledge to identify covariates for plausible a priori models as hypotheses to account for variation in habitat selection patterns (Franklin et al. 2000, Burnham and Anderson 2002, Glenn et al. 2004). Although Wiens et al. (2008) suggest that information-theoretic methods are not strictly necessary because a primary purpose of RSF modeling is prediction, we used Akaike's Information Criterion (AIC) for selecting the most parsimonious models (Burnham and Anderson 2002), while ensuring that 95% confidence intervals of parameter coefficients did not overlap **0.00. Differences in AIC (or Δ_i) values >2 were considered** to indicate that models were statistically distinguishable. We used the likelihood-ratio test ($P = 0.05$) to identify models that merited further consideration.

RSF Model Development

We initiated the modeling process by comparing a small number of models (5–6) for each study area that included map-based (or planimetric) and physical environmental covariates (slope, aspect, elevation, and distances to roads, streams, and nests), including their quadratic and pseudo-**threshold (i.e., $\log_e$) transforms. We modeled aspect using trigonometric functions that included an interaction with the** tangent of slope (Stage 1976). Then, after finding no strong correlations (>0.4) among independent vegetation variables except basal area of trees >66 cm in diameter, which was correlated with QMD at KLAM ($r = 0.71$), we developed separate models that included important map-based variables plus either basal area, total tree density, or QMD and SDI (including linear and quadratic terms). We then evaluated map-based factors + patch-condition variables in models that contained the density of trees and basal area, each by size class. We included an interaction term that included distance to nests and basal area of large trees (and also QMD) because the apparent influence of large trees decreases with increased distance from nest sites (Ripple et al. 1997, Meyer et al. 1998). We selected 5–7 top models among those combinations (approx. 25 models) for further development. To these models, we added covariates representing basal areas of specific conifer species and all hardwoods, as well as counts of shrubs, snags and coarse woody debris, resulting in an additional 30 models. Finally, we compared the top 5–8 models among the 60–61 total models from individual study areas by combining data across all 3 study areas. We used selection ratios (Manly et al. 2002:141, McDonald et al. 2006) to evaluate the change in level of selection from unit changes in individual covariates, and used marginal plots to illustrate the influences of important variables that had quadratic or interaction effects by holding other variables constant at their mean values. We reported the top 5 models combined across the 3 study areas; we did not employ model-averaging because the highest-ranking models contained different forms of the same covariates and all other models had very little support, based on Δ_i.

Model testing.—Mindful that, "essentially all models are wrong, but some are useful" (Box and Draper 1987:424), we considered a useful model should be reasonably robust to variation in habitat and environmental conditions resulting from disturbances, mountainous terrain, differences among years, and differences among individual animals (Wiens et al. 2008). Given that maximum likelihood estimators assigned to exponential RSFs are approximate (Manly et al. 2002) and that there is a lack of statistical tests for model fit and accuracy (Boyce et al. 2002, Boyce 2010), the utility of RSF models depends on their ability to predict. We tested the predictive capabilities of the overall RSF by assessing the assumption that the overall model was approximately proportional to probability of use and that it could accurately order owl home ranges according to average relative probability.

We applied *k*-fold cross validation methods described by Howlin et al. (2004), Johnson et al. (2006), and Wiens et al. (2008), except that we compared expected to observed numbers of observations using linear regression and chi-square tests for RSFs from 3 independent study areas. We excluded data from each study area and iteratively re-estimated RSF coefficients of the best overall model for each excluded study area and for the remaining 2 study areas. We regressed estimated RSF relative probabilities of habitat-inventory plots from excluded study areas (observed) against those predicted (i.e., expected) based upon 2-study area RSFs. Following Howlin et al. (2004) and Johnson et al. (2006), we concluded the combined model was different from a random or neutral model if the slope of each regression line was different from zero. Models that are proportional to probability of use should have regression slopes not different from 1.0, an intercept of zero, and high R^2 values (Howlin et al. 2004, Johnson et al. 2006).

In addition, having independent study-area specific RSFs allowed us to determine the consistency and relative strengths of coefficients of individual model covariates among the 3 study areas. Coefficients of an overall RSF that is useful over wide geographies should not differ substantially and standard errors should not overlap zero when RSFs are estimated separately for independent study areas. We used paired *t*-tests to compare RSF model coefficients to assess whether changes in availability by iteratively removing each study area's data influenced the relative probability of selection. Finally, we believe that a useful model should have the capability to identify low, moderate, and high quality home ranges, so we followed the recommendations of Johnson et al. (2006) of applying chi-square tests for each observed and expected proportion to determine in which RSF probability-bins the observed frequency might differ from expected. A non-significant chi-square value indicates a model that is approximately proportional to use. Howlin et al. (2004) and Johnson et al. (2006) advocated the use of GIS to provide equal-area binning of the relative probabilities of pixels for testing purposes, but because our data were sample based, we used equal-probability bins. As an additional qualitative test and for purposes of illustration, we plotted telemetry points on relative probability maps produced from applying the combined RSF to habitat-inventory plots, smoothed into low to very high relative probabilities of selection.

RESULTS

Database

We sampled habitat selection by 71 radio-tagged spotted owls in the 3 study areas (Table 2). We delineated 133 12- to 18-month sets of telemetry points, and recorded 10,242

Table 2. Summary of database of northern spotted owls in 3 study areas in southwestern Oregon (OR) and northern California (CA), USA, 1998–2006.

Parameter	Klamath Falls, OR	Medford, OR	Yreka, CA
Years of study	2002–2006	1998–2003	1998–2003
Spotted owls radio-tracked	24	26	21
Strata[a]	45	51	37
Telemetry points	2,834	4,390	3,018
Inventory plots[b]	4,029	2,469	1,807

[a] Sample of telemetry locations acquired during 12- to 18-month period and associated habitat-inventory plots within a spotted owl home range.
[b] Variable-radius inventory plots.

telemetry locations and 8,305 inventory plots within cumulative 95% utilization distributions. We combined the 133 utilization sets with corresponding inventory plots within home ranges into 133 strata for estimating RSFs. We acquired slightly more telemetry data during the March–September nesting season than the non-nesting season (54% vs. 46%).

Based upon data from inventory plots, we found wide variation in habitat conditions within owl home ranges among the 3 study areas. Inventory plots sampled at MED contained >300 small-diameter (<25 cm dbh) trees/ha versus <201/ha at the other 2 areas, and had no appreciable red fir or sugar pine. Instead, the MED plots contained about twice as much basal area of Douglas-fir and white fir trees, more hardwood basal area, and greater densities of shrubs than plots at the other 2 study areas. We found the largest amounts of ponderosa pine at inventory plots within owl home ranges at YREK. In some cases, a single large tree provided the majority of basal area, although in many parts of our study areas basal area was the sum of numerous small trees, similar to Camp (1999).

We observed several differences among univariate comparisons (t-test, $\alpha = 0.05$) between all inventory plots and those assigned to nearest telemetry points. Compared to overall inventory plots, plots associated with telemetry points were closer to nest sites and streams, contained trees with larger QMD, greater densities and basal area of trees >66 cm diameter at breast height (dbh), greater basal area of Douglas-fir (except at KLAM), and more incense cedar (except at YREK). Plots associated with locations used by radio-tagged northern spotted owls at KLAM contained greater basal area in hardwoods, and telemetry locations contained more shrubs, except at KLAM.

We observed that 4–6 spotted owls at KLAM and MED moved to lower elevations for 6–8 weeks each winter, roosted in north-slope timber stands, and hunted within adjacent oak savannahs or manzanita shrubfields. Walk-in observations at night revealed that these owls hunted from scattered trees or snags ≤600 m from the nearest conifer forests. Approximately 8% of all telemetry locations occurred in patches with low tree basal area (<14 m^2/ha) during those periods.

Resource Selection Modeling

Top models for all 3 study areas combined included 3 abiotic or map-based variables: distance to nests (NEST), distance to streams (STREAM), and SLOPE (Table 3). Relative probabilities of habitat-inventory plots being selected at night declined rapidly with distance from nests and streams and increased with increasing slope. Aspect, slope-aspect interaction (HEATLOAD), elevation, and distance to nearest roads were not important.

The strongest support for vegetative variables in top overall models for the 3 study areas combined included QMD, basal areas of Douglas-fir, sugar pine and hardwoods, shrub counts, and interactions between basal area of trees ≥66 cm dbh (i.e., $BA_{>66}$) and distance to nests (Table 3). The final RSF then, was estimated as:

$$\begin{aligned} w(x) = \exp(&-0.207 \log_e(\text{NEST}+1) \\ &- 0.0403 \log_e(\text{STREAM}+1) \\ &+ 0.00163(\text{SLOPE}) + 0.236(\text{QMD}) \\ &- 0.223(\text{QMD}^2) + 0.0023(\text{BAHDW}) \\ &+ 0.00374(\text{SHRUB}) + 0.00184(\text{BADFIR}) \\ &- 0.0000212(\text{BADFIR}^2) + 0.00556(\text{BASUG}) \\ &+ 0.00181(\text{BA}_{\geq 66}) + 0.0000518(\text{NEST}) \\ &- 0.000000423(\text{BA}_{\geq 66} \times \text{NEST}) \end{aligned} \tag{2}$$

Table 3. Coefficients and standard errors for habitat and environmental covariates in top discrete-choice resource selection functions for northern spotted owls in 3 mixed conifer study areas in southwestern Oregon and northern California, 1998–2006.

	Model A		Model B		Model C		Model D		Model E	
Covariate	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Log(NEST + 1)	−2.07e−1	8.57e−3	−2.08e−1	8.61e−3	−2.07e−1	8.57e−3	−2.07e−1	8.54e−3	−2.07	8.51e−3
Log(STREAM + 1)	−4.03e−2	3.78e−3	−3.96e−2	3.79e−5	−3.95e−2	3.78e−3	−3.97e−2	3.79e−3	−4.00e−2	3.78e−3
SLOPE	1.63e−3	6.70e−3			1.63e−3	6.70e−3				
SDI_{25-56}							1.43e−3	9.75e−4	2.02e−3	1.21e−3
QMD	2.36e−1	6.26e−2	2.35e−1	6.24e−2	2.14e−1	6.02e−2	2.18e−1	6.13e−2		
QMD^2	−2.23e−1	5.39e−2	−2.01e−1	5.52e−2	−1.58e−1	5.24e−2	−1.56e−1	5.27e−2		
$BA_{\geq 66}$	1.81e−3	5.39e−4	1.82e−3	5.41e−4			1.84e−3	5.44e−4	3.27e−3	3.44e−3
${BA_{\geq 66}}^2$									−2.16e−5	1.42e−5
BAHDW	2.30e−3	5.52e−4	2.28e−3	5.56e−4	2.52e−3	5.63e−4	2.13e−3	5.43e−4	1.88e−3	5.65e−4
SHRUB	3.74e−3	8.13e−4	3.68e−3	8.14e−4	3.81e−3	8.19e−4	3.61e−3	8.12e−4	3.63e−3	8.15e−4
BADFIR	1.84e−3	6.21e−4	1.85e−3	6.21e−4	2.12e−3	6.26e−4	1.78e−3	6.19e−4	1.84e−3	6.25e−4
$BADFIR^2$	−2.12e−5	8.85e−6	−2.14e−5	8.88e−6	−2.31e−5	8.91e−6	−2.31e−5	8.91e−6	−2.34e−5	8.92e−6
BASUG	5.56e−3	9.74e−5	5.61e−3	1.49e−3	5.36e−3	1.46e−3	5.48e−3	1.49e−3	5.48e−3	1.49e−3
QMD*NEST					−1.98e−5	8.38e−6				
$BA_{\geq 66}$*NEST	−4.23e−7	1.71e−7					−4.10e−7	1.68e−7	−3.72e−7	1.71e−7
NEST	5.18e−5	4.59e−6			5.71e−5	4.56e−6	5.15e−5	4.59e−6	5.10e−5	4.58e−6
Δ_i[a]	0.00		2.8		9.2		14.4		24.6	
Model rank	1		2		3		4		5	

[a] Differences in Akaike's Information Criterion (AIC) relative to the smallest AIC value (Burnham and Anderson 2002); models with values >2 are considered distinguishable.

Table 4. Selection ratios [exp(coefficient)] for variables in the top resource selection function for radio-tagged northern spotted owls in 3 mixed conifer study areas in southwestern Oregon and northern California, 1998–2006. Selection ratios measure the multiplicative change in relative probability of selection when a variable changes by 1 unit, assuming all other variables remain constant. Selection ratios were not estimated for variables involved in quadratic effects of interactions because those ratios vary with values of other variables.

Variable	Acronym	Selection ratio	Approx. 95% CI
Distance to nest (m)	NEST	0.813	0.806–0.820
Distance to stream (m)	STREAM	0.961	0.956–0.965
Slope (°)	SLOPE	1.002	1.001–1.003
Quadratic mean diam (cm)	QMD	NA	NA
Basal area of Douglas-fir (m^2/ha)	BADFIR	NA	NA
Basal area of trees ≥66 cm diam	$BA_{\geq 66}$	NA	NA
Nest distance and $BA_{\geq 66}$ interaction	NEST × $BA_{\geq 66}$	NA	NA
Basal area of hardwoods (m^2/ha)	BAHDW	1.002	1.001–1.003
Shrub density (no./0.2 ha)	SHRUB	1.004	1.003–1.005
Basal area of sugar pine (m^2/ha)	BASUG	1.006	1.004–1.006

The top model indicated that relative probabilities of selecting patches at night were associated with quadratic, or unimodal distributions of both QMD and basal area of Douglas-fir trees. Relative probabilities of habitat-inventory plots with high basal area of large trees being selected decreased with distance to nests. Relative probabilities that patches were selected at night increased linearly with increasing basal area of sugar pine and hardwoods and with increasing shrub counts. Although some models suggested a positive linear effect for SDI of intermediate-sized trees (25–56 cm dbh), the 95% confidence intervals overlapped 0.0 for that covariate, so we did not retain it in the final model. No models indicated support for pseudo-threshold relationships for vegetation covariates. We found no strong support among top models for tree density-by-size classes, basal area of ponderosa pine, white fir or red fir, or for density estimates of snags and coarse woody debris. However, some support was evident for a positive linear effect of basal area of trees of 25–66 cm dbh at KLAM, for a positive linear effect of basal area of incense cedar at MED, and for a negative influence of increasing basal area of ponderosa pine at MED.

Selection ratios (Table 4) indicated strong negative effects on relative probability of selection as distance to nest sites and to streams increased. Among other effects, the selection ratio for basal area of hardwoods suggested that the estimated relative probability of an owl selecting a patch at night increased by approximately 2% for each additional 10% increase in basal area of hardwoods, approximately 4% for each 10% additional increase in the number of shrub clumps/ 0.2 ha, and 6% for each 10% additional increase in basal area of sugar pine trees. Marginal plots for important model variables involved in quadratic or interaction effects (Fig. 2) indicated that the relative probability of a location within an owl's home range being a selected point for foraging declined rapidly for the first 200–300 m from nest sites (Fig. 2A). Also, relative probability appears maximized in patches with approximately 25–35 m^2/ha basal area of Douglas-fir trees (Fig. 2B). The relative probabilities of selected patches having high basal area of trees >66 cm dbh declined to low values beyond 400 m from nests (Fig. 2C). Finally, relative probability of selection appeared maximized in patches of trees with average QMD of 40–55 cm (Fig. 2D).

Model validation.—Model performance evaluations involving independent study-area RSFs indicated that nearly all coefficients for individual variables in the top model did not differ among the 3 paired study-area RSFs (Table 5), with the exception of basal area of hardwoods when MED data were excluded. Yet, variation in availability among study areas (and probably smaller sample sizes) had a detectable

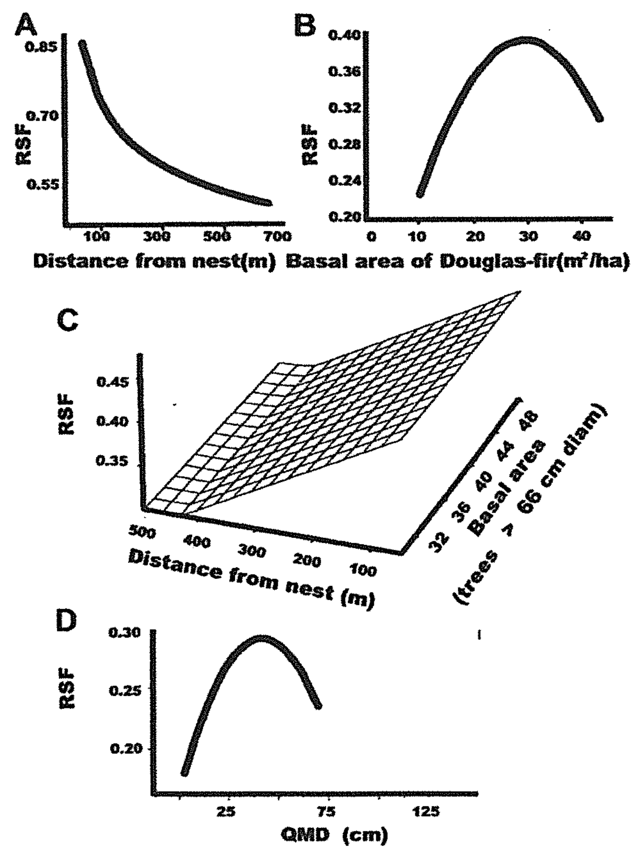

Figure 2. Marginal plots for relative probability values based on applying the top-ranked resource selection function (RSF) for northern spotted owls monitored from 1998 to 2003 at Medford, Oregon and Yreka, California, and from 2002 to 2006 at Klamath Falls, Oregon, in which all other independent variables are held constant at their means. Variables in the top-ranked model include: (A) distance from nest sites; (B) basal area of Douglas-fir trees; (C) basal area of large trees (>66 cm dbh) with increasing distance from owl nest sites; and (D) quadratic mean diameter (QMD; diam of a tree of average basal area in a patch).

Table 5. Cross-validation comparison of coefficients and standard errors (SE) of resource selection functions (RSF) for radio-tagged northern spotted owls monitored from 1998 to 2003 at Medford, Oregon and Yreka, California, and from 2002 to 2006 at Klamath Falls, Oregon. Models were constructed from covariates of overall top-ranking model in Table 3 with data from single-study areas removed and excluding the interaction between basal area of trees ≥66 cm and distance to nest sites.

	MEDFORD + YREKA		MEDFORD + KLAMATH		KLAMATH + YREKA	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Log(NEST + 1)	−2.26e−1	1.24e−2	−2.34e−1	0.99e−2	−1.80e−1	1.07e−2
Log(STREAM + 1)	−4.60e−2	4.69e−3	−4.22e−2	4.90e−3	−3.26e−2	4.37e−3
SLOPE	1.95e−3	7.06e−4	1.35e−3	8.69e−4	1.88e−3	8.49e−4
QMD	1.77e−1[a]	1.12e−1	2.85e−1	7.17e−2	3.93e−3	6.77e−2
QMD^2	−9.30e−1	9.62e−2	−1.86e−1	5.87e−2	−1.64e−1	5.98e−2
BADFIR	2.60e−3	6.67e−4	1.15e−3[a]	7.88e−4	2.66e−3	8.86e−4
$BADFIR^2$	−2.60e−5	9.52e−6	−1.25e−5	1.04e−5	−3.22e−5	1.65e−5
BASUG	1.46e−3[a]	2.68e−3	7.21e−3	1.78e−4	6.212e−3	1.51e−3
BAHDW	1.92e−3	5.95e−4	2.29e−3	5.78e−4	4.58e−3[b]	1.19e−3
SHRUB	4.89e−3	9.15e−4	1.89e−3	1.06e−4	3.95e−3	1.04e−3

[a] 95% Confidence interval overlapped 0.0.
[b] Coefficient differed from others in same row.

influence on RSF models, because confidence intervals for coefficients for a few covariates overlapped 0.0. These included QMD and sugar pine for MED + YREK (i.e., KLAM excluded) and basal area of Douglas-fir and shrub counts for the RSF for MED + KLAM (i.e., YREK excluded).

Regressions between observed and predicted RSF values of excluded independent study-area datasets indicated that the overall RSF was approximately proportional to use, because intercepts were zero (except at YREK), slopes were greater than zero, overlapped 1.0, and R^2 values were high. Regressing the independently estimated KLAM RSF values against those produced by re-estimating the top RSF by combining MED and YREK data returned an intercept of 0.0028 (SE = 0.0014), a slope of 0.918 (SE = 0.046), and $R^2 = 0.879$. When the independently estimated MED RSF relative probability values were regressed against those produced by re-estimating the top RSF by retaining data from KLAM and YREK, the intercept was −0.027 (SE = 0.015), the slope was 1.046 (SE = 0.045), and the $R^2 = 0.880$. When we regressed the YREK RSF values against those produced by an RSF constructed by combining MED and KLAM data, the intercept was 0.098 (SE = 0.003), slope was 0.963 (SE = 0.021), and R^2 was 0.890. Inspection of the data for individual owl home ranges for that regression indicated that the inconsistent intercept YREK was related to 6 owls at KLAM and MED that made winter movements to lower elevations and used habitats that did not occur frequently in home ranges at YREK. In cross-validation comparisons that involved 10-fold binning the relative probability values and re-estimating the top model at each study area, each chi-square test was non-significant ($P = 0.994$ at KLAM; $P = 0.787$ at MED; $P = 0.787$ at YREK), indicating the model had acceptable predictions and could correctly assign relative probability values to each owl home range. An ANOVA comparing RSF values among the 3 study areas indicated that average values of spotted owl home ranges at MED were greater than those at KLAM and YREK ($P = 0.043$). The top overall model was capable of predicting telemetry-point distributions at each of the 3 study areas (e.g., KLAM; Fig. 3).

DISCUSSION

We used a repeated-study approach to estimate a discrete-choice RSF that appears capable of accurately predicting foraging locations and is reasonably robust to variation in habitat availability across our study region. Covariates in the RSF model are generally consistent with expectations from previous research on spotted owls and their prey base, and with predictions from foraging theory. Such theory suggests that interactions among vegetation structures and abiotic factors should influence the balance between costs (e.g., energy expenditure, risk to being killed by a predator while foraging) and gains (e.g., energy or nutritional benefits) of alternate patch choices (Partridge 1978, Rosenzweig 1985, Stephens and Krebs 1986). Our analyses also identified spatial interactions between physical environmental factors and fine-scale vegetation details that are associated with foraging habitat selection. For example, northern spotted owls spent disproportionate amounts of time searching for prey in forest patches near or in riparian zones of small, low-order streams. Solis and Gutiérrez (1990), Carey (1995), and Carey and Peeler (1995) made similar observations for northern spotted owls, as did Irwin et al. (2007) for California spotted owls. Our results are also consistent with previous research that found that habitat choice by spotted owls is influenced by hardwood trees (Glenn et al. 2004, Irwin et al. 2007) and understory shrubs (Carey 1995) that produce fruit and mast supplies for the owls' small mammal prey.

Also similar to previous investigators (Hunter et al. 1995, Ripple et al. 1997, Meyer et al. 1998, Thome et al. 1999), we found strong empirical support for selection of patches with large (>66 cm dbh), presumably older trees when such trees were near nest sites. The statistical interaction between basal area of large trees with distance from nest sites in our RSF probably reflects selection of such large trees for nests (Buchanan et al. 1993, Hershey et al. 1998, LaHaye and

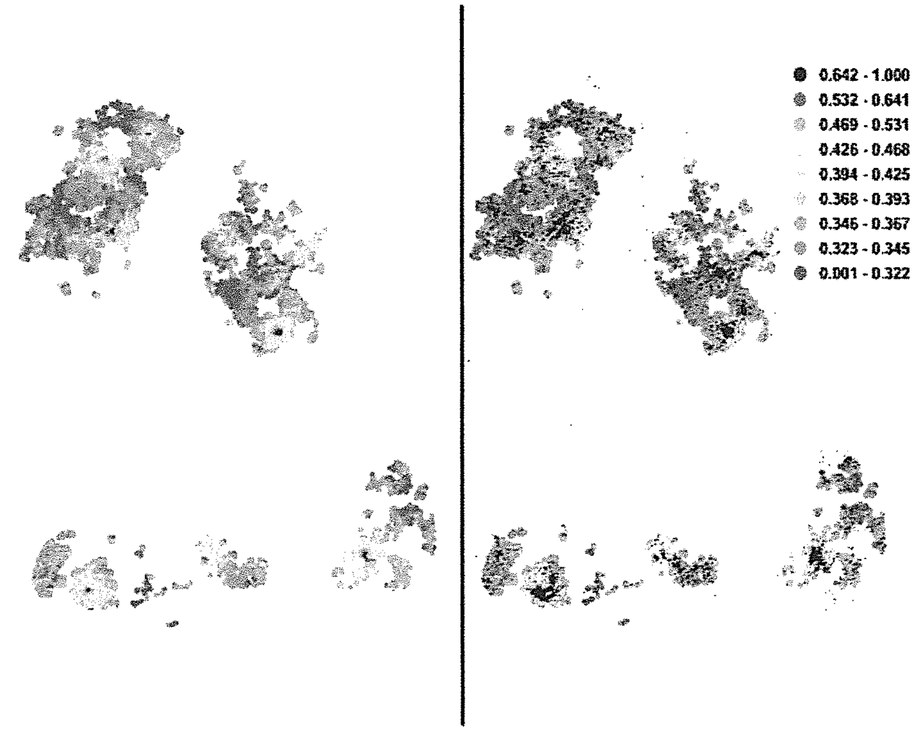

Figure 3. Illustration of the application of our regional resource selection function (RSF) to habitat-inventory plots in the Klamath Falls study area (KLAM) of southwestern Oregon, USA. Colored circles represent increasing relative probabilities of use by northern spotted owls from low (blue) to high (red). We overlaid the relative probability maps on the right half on triangulated locations of radio-tagged northern spotted owls (black dots), demonstrating a close association between predicted and actual nocturnal use by 26 radio-tagged spotted owls monitored from 2002 to 2006. Telemetry points (dots) beyond the colored areas were outside the 95% contour of the utilization distributions and therefore had no associated habitat-inventory plots.

Gutiérrez 1999), as well as concentrated use near nests, intuitive for central-place foragers (Carey and Peeler 1995). We considered this effect an interaction, rather than a confounding effect, because it was biologically plausible and was statistically significant (Hosmer and Lemeshow 1989:67). This was further supported by correlation analysis indicating that basal area of trees >66 cm dbh did not vary with distance from nests ($r < 0.2$, $P = 0.29$). If selection for such large trees occurred equally at all locations within home ranges, the interaction term in our model would not have been statistically significant. Selection of large trees for nests and choice of nest-site location may afford greater protection against predators and/or inclement weather (Newton 1979, Buchanan et al. 1995), but the need to care for nestlings may restrict travel. If that hypothesis holds, then tradeoffs probably occur between conditions that promote nestling survival and other conditions that promote access to abundant sources of prey (Franklin et al. 2000). For example, Carey et al. (1992) found that spotted owls are capable of depleting populations of prey in intensively hunted sites, which would include areas near nest sites. Therefore, it seems plausible that an optimal landscape for spotted owls in this region might include a grove or stand of large-diameter trees that **promotes security while raising young that is embedded** within a heterogeneous forest landscape that provides high-quality foraging habitat (Franklin et al. 2000). In our study areas, selection of patches with such large trees apparently extended to about 400 m from nest sites (Fig. 2C), which would encompass an area of 50 ha.

We also identified several influences on spotted owl habitat selection that have not been included in previous studies of northern spotted owls. For example, we found that the relative probability of a patch being selected at night increased in unimodal (convex) relationships with increasing QMD and with basal area of Douglas-fir trees, suggesting that an optimal forest overstory condition may exist that promotes successful acquisition of prey. Densities of important prey such as northern flying squirrels (*Glaucomys sabrinus*) are anticipated to be low in open forest patches with low basal area (Waters and Zabel 1995). Alternative prey that occur in open areas, such as woodrats (*Neotoma* spp.), might be less readily captured if the areas contain extremely dense understory shrubs (Solis and Gutiérrez 1990) or hardwoods. Such very dense protective cover for prey could explain why hardwoods were not selected by spotted owls at MED, where hardwoods were highly abundant, whereas owls may acquire prey as the prey seek mast on the surface of dense manzanita shrub mats. Similarly, northern flying squirrels may be relatively abundant but less readily captured in very dense conifer patches with high basal area. Douglas-fir trees may be a favored tree species for foraging because red tree voles are associated with intermediate basal areas **(approx. 20 m^2/ha)** of trees 45–90 cm dbh (Dunk and Hawley 2009), and because of associations between Douglas-fir and the hypogeous ectomycorrhizal fungi that support northern flying squirrels (Carey and Peeler 1995, Lehmkuhl et al. 2006). Also, we found that basal area of sugar pine, which was not abundant, exerted strong effects in

RSF models. Sugar pine may be important for spotted owl prey because sugar pine cones are large (up to 56 cm in length) and produce large amounts of large seeds (>150 seeds/cone at 0.23 g/seed, Kinloch and Scheuner 1990). Finally, we observed that some 25% of spotted owls often foraged within oak savannahs in winter at lower elevations or within manzanita shrubfields (in all seasons) that contain low basal areas of conifer trees. The presence of a few scattered trees or snags probably facilitated hunting for prey, which we presume included dusky-footed woodrats (*Neotoma fuscipes*). For example, a pair of spotted owls at YREK made extensive use of an 8- to 10-yr-old 120-ha burn at high elevation that contained extensive manzanita patches and scattered live trees.

Contrary to anticipated negative influences, our top-ranking RSF did not include SDI, density of small-diameter trees, or overall tree densities, although coefficients were often in the expected direction in some models we tested. Also, we were unable to confirm that downed woody debris or large snags influenced foraging habitat selection in this landscape. However, densities of such structures were low and highly spatially variable.

Stand-level categories of seral-stages or age classes representing late-successional and old-growth forests have heretofore provided the basis for habitat mapping, predictive modeling, and conservation planning (e.g., Thomas et al. 1990, United States Fish and Wildlife Service 2008) because of consistent results of chi-square analyses that demonstrated disproportionately greater use by northern spotted owls. Indeed, old-forest seral stage and local ad hoc definitions of foraging habitat can accurately predict nesting locations of northern spotted owls (e.g., Zabel et al. 2003). However, spatial interactions and abiotic factors such as proximity to productive riparian zones have not previously been included in conservation planning. Further, such habitat-type categories correlate relatively weakly or in contradictory patterns with population performance measures among northern spotted owls (e.g., Raphael et al. 1996, Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). Such variation led Boyce et al. (2005) and Gosselin (2009) to suggest that the habitat issue for northern spotted owls remains unclear. We suggest that the confusion resulted because vegetation cover-types inadequately capture fine-scale, complex interactions and features that influence population performance among spotted owls, as has been observed for other bird species (Cushman et al. 2007).

Waring and Running (2007) stated that scientists can safely progress from patch, to site or individual organism scales to eco-regional simulations only after attaining reasonably good understanding of factors and principles underlying ecological processes operating at fine scales and after those features have been synthesized into some type of demonstrably reliable model framework. This study, Irwin et al. (2007), and Lehmkuhl et al. (2006) suggest that fine-scale details matter greatly to spotted owls and their prey, thereby calling into question the dependency on coarse stand-level characteristics such as vegetation-type or seral stage. Habitat-type categories at the scale of forest stands may be too coarse to serve as a reliable surrogate for complex interactions among overstory and understory vegetation structure, tree species composition, and the physical environment. Future researchers may want to incorporate basal area by tree species for use in scaling up to larger areas, because of its link with leaf-area index (Oren et al. 1987). Leaf-area index can be measured remotely and has been used in ecosystem models. Doing so might promote development of ecosystem function models that link RSFs for spotted owls with mechanistic models of space use (Moorcroft and Barnett 2008).

Our datasets undoubtedly contain errors commonly associated with telemetry triangulation in mountainous environments and with assignment of vegetation data that may vary across scales finer than the resolution of our telemetry system (approx. 1 ha). Equally important, use-availability studies such as ours do not necessarily provide information on habitat quality or evidence that the preferred conditions are necessary for spotted owl survival and reproduction. Inferences from RSFs are associative, not causative. Primary factors of interest, or environmental exposures, are themselves involved in complex interactions with each other and with other factors that, in turn, may be confounded with still other factors (Riggs et al. 2008).

Despite those caveats, RSFs that are constructed from fine-scale vegetation details and physical environmental influences, and incorporate features of foraging habitat believed to influence owl population fitness may illuminate basic determinants of habitat selection, that is, those factors to which animals are adapted (Manly et al. 2002). For example, we observed winter foraging in relatively open oak stands at lower elevations and in manzanita shrub-fields at all elevations. Such patch conditions might influence survival or reproductive success by promoting high nutritional condition of females prior to egg-laying and incubation, as Meijer et al. (1988) demonstrated for Eurasian kestrels (*Falco tinnunculus*). However, patches of non-coniferous vegetation, often at ecotonal situations at lower elevations, or small burned areas at higher elevations, traditionally have been assumed to be non-habitat for northern spotted owls. We recommend further research on the potential importance of such foraging habitats. Moreover, new research is needed to link RSF models such as ours to indicators of fitness, such as correlating the RSF values at habitat-inventory plots within a core area (approx. 200 ha) with estimates of reproductive success and survival.

MANAGEMENT IMPLICATIONS

The U.S. Fish and Wildlife Service (2010) recommended development of relative risk assessment tools and province-specific definitions of foraging habitat. Our RSF supports both objectives. We believe our analyses also support habitat improvement as integral to conservation and recovery for northern spotted owls in fire-prone, mixed coniferous forests, with caveats that our RSF model should not be applied beyond the ranges of conditions in our study areas and that nest sites require special protection (e.g., Hershey et al. 1998), including retention of greater basal area and large trees.

Silvicultural activities that retain mature sugar pines and **create intermediate basal areas (25–55 m^2/ha)** dominated by 30–60 cm dbh Douglas-fir trees are likely to improve foraging habitats for northern spotted owls by supporting hardwoods and shrubs important to dusky-footed woodrats (Atsatt and Ingram 1983). Residual basal area appears most important, and probably can be achieved in the 1st entry of a silvicultural prescription that emphasizes retention and growth of shade-intolerant trees such as Douglas-fir and sugar pine, which are well adapted to growing in canopy gaps. Gaps between 0.07–0.13 ha provide sufficient light for regeneration of shade-intolerant tree species such as ponderosa pine (Gersonde et al. 2004). Silvicultural prescriptions derived from our study would require testing in an active adaptive management framework.

Discrete-choice RSFs allow conclusions to be made at the population level (Cooper and Millspaugh 1999, Manly et al. 2002), thereby facilitating landscape assessment. Thus, our RSF could assist landscape scale conservation planning by forecasting short-term consequences of alternative silvicultural treatments at scales of a home range or territory-sized **unit (≤400 ha), following McDonald and McDonald (2002)** and scaling up to assess alternative conservation strategies across landscapes, similar to Boyce et al. (1994). Because numerous locations of northern spotted owls have been obtained via surveys or can be identified via modeling (e.g., Zabel et al. 2003, U.S. Fish and Wildlife Service 2010), the RSF can also apply large-scale vegetation data (e.g., Ohmann and Gregory 2002) to assist with forecasting long-term consequences of forest management alternatives at landscape scales when linked with forest-growth simulators and fire-risk models (e.g., Ager et al. 2007). Associated probabilistic maps also could be correlated with demographic performance (Aldridge and Boyce 2007).

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NORTHERN SPOTTED OWL RESOURCE PLAN

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Amended March 7, 2014

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1.0 INTRODUCTION

Within the range of the Northern spotted owl (*Strix occidentalis caurina*) W.M. Beaty & Associates, Inc. (WBA) manages private forestland owned by four separate private owners. These private owners include Red River Forests, LLC, Shasta Forests Timberlands, LLC, Lassen Forest I Pondosa, LLC and Area H, LLC, hereinafter referred to as "WBA managed lands". The general philosophy of these land owners is to maintain and enhance the value of the land and resource base to pass on their legacy to their heirs. Aside from the economic incentives for maintaining the productivity of their forests, the landowners have strong conservation ethics and a willingness to manage their properties as healthy natural areas that provide aesthetic, recreational, wildlife, community, and other values.

The WBA managed lands are located near the eastern edge of the geographic range of Northern spotted owl (NSO). As expected for the peripheral margins of a species geographic range, NSO density is low in this region irrespective of land ownership and management history. Surveys for NSOs have been conducted on WBA managed lands since 1992. Over 1,000 calling stations have been surveyed and in no case has a NSO pair or nest site ever been detected on these lands. However, individual NSOs have been detected on rare occasions during surveys. Follow-up surveys conducted in the vicinity of these sporadic detections have rarely relocated NSOs that had responded at night. A nest, NSO pair, or an area that showed any signs of consistent use by NSOs (accumulations of whitewash, prey remains, regurgitated pellets, molted feathers, etc.) have never been located.

Only a portion of the WBA managed lands lie within the NSO evaluation area (Appendix A). California Forest Practice Rules (CFPRs) specifically define the NSO Evaluation Area (14 CCR § 895.1) which includes portions of Shasta and Siskiyou Counties. Additionally, the U.S. Fish and Wildlife Service (USFWS) recommend several other areas be considered when planning timber operations (USFWS 2008[a]). The Technical Assistance document states that these areas should be evaluated to determine if suitable NSO habitat exists and could be impacted by timber operations, and if so, then surveys or seasonal operating restrictions should be considered to avoid take of a NSO (USFWS 2008[a]). Specifically, this Northern Spotted Owl Resource Plan (NSORP)(14 CCR § 939.9(f)) applies to approximately 91,286 acres of WBA managed lands that lie within the NSO Evaluation Areas and within or adjacent to the those areas specified in the 2008 USFWS guidance document (Appendix A).

2.0 PURPOSE AND NEED

State and federal requirements for the protection of NSOs are continuing to evolve. The understanding of what constitutes suitable habitat for NSOs has increased over time, thus enabling better predictions of NSO occurrence and likelihood of impacts to NSOs associated with timber operations in specific sites. By applying the best available scientific information regarding NSO habitat combined with a long history of NSO survey information, this NSORP (14 CCR § 939.9(f)) establishes a programmatic approach that can be used by WBA and the California Department of Forestry and Fire Protection (Cal Fire) to ensure that take of NSOs (14 CCR § 939.10) will not occur on WBA managed lands.

Surveys for NSOs are typically conducted using a two year protocol prior to harvest activities that might affect NSO habitat or could potentially result in take of NSOs. Usually the first year of surveys is conducted the year prior to scheduled operations and the second year of surveys is conducted immediately prior to the onset of operations for that year. This timing ensures that the most currently available information is used to ensure take of NSOs will not occur. Most timber operations on WBA managed lands are low intensity, single tree selection harvests that may improve habitat, not alter habitat, or remove a small proportion of the habitat. Given the low intensity silvicultural practices on the property that maintain mature forest cover, large trees, and other habitat elements important to NSOs (large snags, cull trees, hardwood, densely forested areas with multiple canopy layers), it is not likely that NSOs or NSO habitats will be adversely impacted by timber operations. Likewise, timber operations are not usually significantly constrained by regulatory requirements to maintain occupied habitat since no nest sites or areas of concentrated use by NSOs are currently known to be present on WBA managed lands.

Developing a programmatic approach to ensure take of NSOs will not occur has proven benefits for WBA managed lands, Cal Fire and USFWS. Such an approach identifies specific information that will be provided in THPs, clearly identifies how habitat suitability is determined, and specifically describes how and when NSO surveys will be conducted, and establishes a procedure that will be applied in the event that a NSO is detected within an area that may be subject to timber harvesting. A feedback mechanism also ensures that as time passes and knowledge of where and how NSOs may be using habitat within the area covered by this NSORP increases, all parties share a common understanding as to how to ensure take of NSO does not occur. By establishing programmatic procedures, WBA and Cal Fire can avoid duplicating efforts and analyses necessary to ensure take of NSOs will not occur.

WBA prepared the original NSORP in cooperation VESTRA Resources, Inc, under the direction of Robert L. Carey a Certified Wildlife Biologist, Private Consulting Biologist No. 0029, and Spotted Owl Expert designated by Cal Fire to fulfill the requirements of 14 CCR § 939.9(a). Also, this NSORP has been edited and amended by Stuart L. Farber, WBA Wildlife Biologist, a Spotted Owl Expert designated by Cal Fire. This NSORP meets the definition of a Spotted Owl Resource Plan (14 CCR § 939.9(f)) which is “a plan that demonstrates an approach to preventing a taking of the northern spotted owl while conducting timber harvest operations. A Spotted Owl Resource Plan necessarily involves more than one timber harvest plan area (14 CCR § 895.1). WBA has previously used programmatic methods to address concerns for NSOs with both the California Department of Fish and Wildlife (DFW) (NSORP 1997) and the USFWS (Northern Spotted Owl Management Plan 1999). While both of these prior agreements were effective, they became obsolete because of changes in how NSO regulations under the CFPRs were being implemented. Based on past experience, there are proven benefits to be derived from this type of programmatic approach.

3.0 OBJECTIVES

A primary goal of this NSORP is to ensure take (14 CCR § 939.10) of NSOs will not occur during timber harvest operations conducted on WBA managed lands. An additional goal is to establish a programmatic approach to addressing NSOs in THPs prepared by WBA such that review of individual THPs as related to NSOs can be streamlined. To achieve these goals the objectives of this NSORP are to:

(1) Describe a method to determine when NSO surveys are appropriate.

(2) Establish a method that can be used to determine what areas of habitat will be surveyed when preparing THPs on WBA managed lands.

(3) Describe the protection measures that will be used in THPs implemented on lands managed by WBA to prevent take of NSOs.

(4) Provide baseline information to Cal Fire as a prerequisite of this NSORP.

(5) Describe a method of information exchange to assure Cal Fire that WBA's operations are in compliance with the NSORP.

Approval of this NSORP by Cal Fire will fulfill the requirements of 14 CCR § 939.9(f) with respect to NSOs for individual THPs filed under this NSORP. The criteria of 14 CCR § 939.10 has been used and it has been determined that when the terms and conditions detailed in this NSORP are fulfilled, that take of NSO will not occur.

4.0 SUITABLE HABITAT

The following methods will be used to determine when NSO surveys are appropriate and what areas of habitat will be surveyed. The CFPRs describe forest stand conditions that are "functional" NSO nesting, roosting, and foraging habitat (14 CCR § 895.1). Additionally, Cal Fire in cooperation with the USFWS has provided guidance to THP submitters on criteria that should be used to determine habitat suitability for NSOs in portions of interior northern California (USFWS[b]). Both the CFPRs and the USFWS use forest conditions to define NSO habitat. The USFWS adds other physiographic features and spatial elements that influence the likelihood that a particular area will support NSOs, however several of these parameters are not stated in quantitative terms. Both of these definitions include parameters such as tree diameter, basal area, density of trees of certain sizes, and canopy closure and include structural elements such as multi-storied canopies, large snags and trees with deformities, large woody debris, and decadence within the stand. Topographic relief and microclimate may also influence suitability of habitat. This NSORP uses the USFWS guidance (USFWS 2008[b]) document to categorize NSO habitat on WBA managed lands.

A critical component of the USFWS guidance (USFWS 2008[b]) is proximity of one habitat type (nesting and roosting) to another (foraging). Recent scientific research efforts to predict the likelihood of a NSO inhabiting specific forest stands in northern California have used a model selection methodology (Zabel et al. 2003). This method uses statistical analytical procedures to identify precisely which forest attributes, in what types of spatial arrangement are common among many sites known to be used by NSOs. Based on radio telemetry data from several study sites in northern California that are similar to areas covered under this NSORP, the investigators developed individual regression models that evaluated the importance of an array of variables with respect to NSO habitat suitability. The individual models were then combined to include the variables that contributed the most to predicting habitat suitability. These variables were then ranked for importance and combined into a single regression equation. The combination of parameters that best explain the differences between sites that support NSOs, and sites that do not support NSOs are expressed in a model that best predicts NSO occupancy. The final model indicated that a combination of foraging and nesting and roosting habitat was a key predictor of occupancy by NSOs (Zabel et al. 2003).

It has also been shown in other studies that NSO habitat is a combination of nesting and roosting areas interspersed and juxtaposed with foraging areas (Farber and Crans 2000, Franklin et al. 2000, Hunter et al. 1995, Irwin et al. 2004, Zabel et al. 2003). In northern California, Zabel et al. (2003) used a model selection approach and found the availability of different types of habitat, specifically nesting, roosting, and foraging habitats within a NSO core use area, could predict the likelihood that a NSO would occur in a specific area. Zabel et al (2003) concluded that their results are a good predictor of NSO occupancy within a given 200 ha (500 acre) core area and that at the 0.20 to 0.50 probability level, these results may be useful in predicting absence of NSOs within their study area. As noted above, the area of inference from Zabel et al. (2003) is similar to the lands covered under this NSORP in terms of forest type, Klamath and Sierra Mixed Conifer types, with moderate topography and Mediterranean climate.

In conclusion, based on this best available scientific information, WBA has developed a method for determining where NSOs are likely to be detected during surveys (USFWS 2011). Thus in general, areas where a NSO is likely to be detected will be surveyed; areas where NSOs are not likely to be detected will be excluded from surveys. Where NSOs are more likely to be detected, all surveys shall follow the most current USFWS protocol (USFWS 2011), except for the deviations stated in the NSORP, and future changes to the USFWS protocol. The survey stations shown on the THP maps shall be used for all survey visits. Survey stations will be marked on the ground with paint or flagging if necessary to facilitate consistent station relocation or located at clearly identifiable locations (road intersections, marked Section lines, etc.).

4.1 Habitat Assessment Procedure

All WBA managed lands that will be subject to timber harvesting and are within the NSO Evaluation Area (14 CCR § 895.1) or within or adjacent to townships identified in the USFWS Guidance document (Appendix A), will be evaluated for the potential to provide habitat for NSOs. Habitat function will be determined based on the WBA timber inventory that identifies areas that meet the criteria of High Quality Nesting and Roosting Habitat, Nesting and Roosting Habitat, Foraging Habitat, and Low Quality Foraging Habitat as described in USFWS guidance (USFWS 2008[b]). However, because stands that meet the criteria for Foraging or Low Quality Foraging Habitat are very unlikely to support NSOs if there is not at least some Nesting and Roosting habitat nearby, several conditions are included in determining which stands will be surveyed for NSOs. A combination of forest inventory data, aerial photograph interpretation, and field reconnaissance will be used to validate survey area delineation. The WBA inventory design and specifications are very robust in terms of collecting information regarding wildlife habitat. The forest inventory data concerning the habitat parameters of tree diameter, basal area, density of trees of certain sizes, and canopy closure used in the NSO habitat definitions produce results that have a low variance and a high degree of statistical certainty. The forest inventory data combined with the WBA geographic information system (GIS) allows for a robust spatial analysis that depicts proximity to other stands (habitat polygons) that are used in determining where surveys for NSOs will be conducted. The results of habitat assessments for NSOs are validated during field reconnaissance and through the use of aerial imagery. Annual updates to the WBA forest inventory are conducted and will be used to determine areas of NSO habitat on an annual basis. As recommended by Zabel et al. (2003), WBA uses a conservative interpretation of the available science and accepts a probability of use as low as 0.20 when classifying NSO habitat. For the purposes of this NSORP, NSO habitat is defined as:

4.2 Foraging Habitat

(1) Foraging habitats are areas where forest stands meet the structural criteria for Foraging habitat or Low Quality Foraging habitat and are within 0.5 miles of areas that at least meet the criteria for Nesting and Roosting habitat (USFWS 2008[b]).

(2) Foraging habitats are also areas where stands meet the structural criteria for Foraging habitat or Low Quality Foraging habitat (USFWS 2008[b]) and it is unknown whether any areas of at least Nesting and Roosting habitat exist within 0.5 miles (i.e. this assumes Nesting and Roosting habitat maybe present in areas where WBA does not have timber inventory data and remotely sensed data are unavailable or inconclusive).

4.3 Nesting and Roosting Habitat

(1) Nesting and Roosting habitats are areas that meet the criteria for High Quality Nesting and Roosting Habitat or Nesting and Roosting Habitat (USFWS 2008[b]).

4.4 THP Measures and Site-Specific Suitable Habitat Assessment

To ensure take of Northern spotted owls will not occur from any current and future WBA forest management activities a site-specific suitable habitat assessment shall be completed as part of all proposed THPs. USFWS (2008[b]) guidance states the use of "thresholds" to guide habitat assessment often simplifies more complex habitat conditions. The USFWS also acknowledges that suitable habitat retention guidelines are based on means for the entire Northern Interior Region (USFWS 2008[b]), and retention of suitable habitat should also be guided, when possible, by site specific abiotic considerations including: (1) Distance to nest, (2) Contiguity, (3) Slope position, (4) Aspect, (5) Elevation and (6) Tree species composition. THPs shall follow these guidelines as suggested by the USFWS, to complete a site-specific habitat assessment for all occupied NSO activity centers on or within 1.3 miles of WBA managed lands. Each assessment shall include review of:

(1) Suitable habitat type maps based on USFWS 2008[b].

(2) Forest inventory information including suitable habitat species composition, QMD, basal area, canopy closure and presence of larger trees and forest structures.

(3) Digital ortho photography

(4) Location of all previously known nest, roost and detection locations.

(5) Abiotic factors include the suitable habitat distance to nest, distance to stream, slope and overall topography, elevation, aspect and habitat connectivity.

The intent of the assessments are to use site-specific (ie. activity center specific) information to identify current and future habitats on WBA managed lands that should be retained. The habitat retention is to ensure "take" of Northern spotted owl will not result from any current or future WBA forest management activities. This site-specific approach is completed in lieu of using a one-size-fits-all approach that uses robust habitat retention guidelines to ensure "take" does not occur (USFWS 2008[b]). By using a site-specific assessment, as recommended by the USFWS (2008[b]), specific local conditions and habitat shall be used to identify habitat retention within the 0.5 mile Core Use Area and the 1.3 mile Foraging Area of each activity center. Habitat retention, for the purposes of this NSORP, are those habitat stands designated by the S.O.E. and Cal Fire during the site-specific assessment that are necessary to ensure take will not occur from the proposed NSORP, and subsequent THPs relying on this NSORP.

Also, during the site-specific assessments, specific stands may be identified as having high abiotic conditions, but relatively lower, current suitable habitat conditions. In the future, if these high abiotic condition stands are managed for retention of suitable habitat structures (ie. snags, down logs, dense groups of trees, platforms) and are managed to grow into larger size and higher density suitable habitats, these stands have high value for nesting, roosting and foraging Northern spotted owls. Accordingly, voluntary retention means, for the purposes of this NSORP, are habitat stands designated by the S.O.E. and reviewed by Cal Fire during the site-specific assessment as stands where voluntary retention and management would benefit conservation of NSO sites in the future. In other words, these voluntary retention stands are not necessary to ensure take will not occur from this proposed NSORP, and subsequent THPs relying on this NSORP, rather, these stands would benefit conservation of the species.

4.4.1 0.5 Mile Core Use Area

The concept of “core areas” was first proposed as areas within a home range receiving concentrated use by territorial animals (Samuel *et al*, 1985). Within habitats nearest the nest tree(s), core areas typically include the current nest tree, alternate nest trees, and frequently used roost trees, if known. More recently, numerous scientific studies have been conducted to determine which scales of habitat may be important for NSOs. An observation study in the Klamath province found the mean nearest neighbor distance between owl territories was 389 acres (Hunter et al, 1995). Another observation study found that owl core areas in the Klamath province are found to have significantly different habitats than random sites at the 494 acre scale (Gutierrez et al. 1998). Also, in the southern Cascades the best owl survival model used a 412 acre circle (Anthony et al. 2002). In other words, core use areas for Northern spotted owls are those 0.5 mile areas that are used disproportionately within home ranges (Bingham and Noon 1997; Irwin et al, 2004, Irwin et al. 2010, USFWS 2008[b]). Also, studies have described both the amount and quality of habitat (biotic) and location of the habitat (abiotic) as important factors in retaining Northern spotted owls in forested landscapes (Clark 2002, Irwin et al. 2004, Irwin et al. 2010, USFWS 2008[b]).

Accordingly, suitable habitats within the 0.5 mile Core Use Area shall be assessed to ensure that take will not occur as a result of any WBA forest management activities. The site-specific assessment shall use information described in Section 4.4 of this NSORP, and if necessary, designate habitat retention or identify voluntary habitat measures within the 0.5 mile Core Use Area. Accordingly, if a NSO activity center is located within WBA managed forestland or within 1.3 miles of WBA managed lands the following measures shall be assessed, or when a new activity center is established shall be assessed, and implemented:

THP Measures and Maintenance
Summary of 0.5 Mile Core Use Area

(1) Nesting Core Use Area shall be a 0.5 mile radius circle (502 acre) centered on the Northern spotted owl activity center.

(2) Suitable habitat shall be retained following site-specific review by an S.O.E. and CAL FIRE, using guidance provided by the USFWS (2008[b]),in order of importance: (1) High Quality Nesting and roosting habitat (2) Nesting and roosting habitat (2) Foraging habitat (3) Low Quality Foraging habitat. Foraging and Low Quality Foraging habitat in abiotically favorable locations may be retained instead of nesting and roosting habitats in less favorable locations.

(3) Suitable habitat shall be retained also considering: (1) Current nest trees (2) Alternative and historic nest trees (3) Current and historic detection locations (4) Natural and manmade landscape features such as ridges, streams, meadows, roads and previous harvest boundaries.

(4) Abiotic factors are significant predictors of owl use. To meet the habitat standards the following abiotic factors (in order of importance) shall be considered when deciding between which habitats to retain: (1) Distance to nest (2) Distance to stream (3) Slope (4) Elevation (5) Aspect

(5) Timber harvesting within habitats specifically retained on WBA managed lands within the Core Use Area are limited to silviculture which would reduce potential threats from wind throw, wildfire, forest pests, tree disease or overstocking, maintains the existing suitable habitat type and structures described in Item 2 and 3 above, and only following a field based assessment by a S.O.E. with concurrence from CAL FIRE.

4.4.2 1.3 Mile Foraging Outer Ring Area

Results of several studies have also indicated that roosting and foraging areas, represented by both daytime and nighttime telemetry locations, are best predicted by abiotic conditions (Clark 2002, Irwin et al. 2010). Suitable habitats within the 1.3 mile Foraging Outer Ring Area shall be assessed to ensure that take will not occur as a result of any WBA forest management activities. The site-specific assessment uses information described in Section 4.4 of this NSORP, and if necessary, designate habitat retention or identify voluntary habitat measures within the 1.3 mile Foraging Outer Ring Area. Accordingly, if a NSO activity center is located within WBA managed lands or within 1.3 miles of WBA managed lands the following measures shall be assessed, or when a new activity center is established shall be assessed, and implemented:

THP Measures and Maintenance
Summary of 1.3 Mile Foraging Outer Ring Area

(1) Foraging Ring Area includes habitats within a 1.3 mile radius circle (3,380 acre) ring area centered on the Northern spotted owl activity center.

(2) Suitable habitat shall be retained following site-specific review by an S.O.E. and CAL FIRE, using guidance provided by the USFWS (2008[b]),in order of importance: (1) Foraging habitat, (2) Low Quality Foraging habitat. Foraging and Low Quality Foraging habitat in abiotically favorable locations may be retained instead of nesting and roosting habitats in less favorable locations.

(3) Abiotic factors are significant predictors of owl use. To meet the habitat standards the following abiotic factors (in order of importance) should be considered when deciding between which habitats to retain: (1) Distance to nest (2) Distance to stream (3) Slope (4) Elevation (5) Aspect (6) Connectivity.

(4) Timber harvesting within habitats specifically retained by WBA managed lands within the Foraging Use Area are limited to silviculture which would reduce potential threats from wind throw, wildfire, forest pests, tree disease or overstocking, and maintains the existing suitable habitat type and structures described in Item 2 above.

4.4.3 Abiotic Factors

As previously described, abiotic factors are an important predictor of owl use (Clark 2002, Irwin et al. 2004, Irwin et al. 2010). Other studies in the Klamath province have also found that abiotic factors like elevation and slope position help discriminate between owl use areas and random sites (Blakesley et al. 1992). As recommended by the USFWS (2008[b]), when reviewing habitats within 1.3 mile of a known NSO activity center the following descriptions of abiotic factors are used to evaluate habitat quality and potential use:

(1)	Distance to Nest	Distance from the habitat to the active nest site (ie. smaller distance means more use)
(2)	Distance to Stream	Distance from the habitat to either an annual or intermittent stream (ie. smaller distance means more use)
(3)	Slope	Slope position of the habitat (ie. lower third of slope)
(4)	Elevation	Habitat and use is generally a non-linear relationship with a negative coefficient (ie. lower is generally means more use).
(5)	Aspect	Aspect of the habitat (ie. North and East favored).
(6)	Connectivity	Degree of connectivity to other abiotically favorable habitats.

4.5 Suitable Habitat Assessment for New Activity Centers

In the event a NSO is detected in a location not previously occupied, and the detection(s) meet USFWS (2011) standards for an activity center, a site-specific suitable habitat assessment shall be completed. The assessment shall be completed by a S.O.E., designated by Cal Fire to fulfill the requirements of 14 CCR § 939.9(a). The assessment shall follow the procedures described in Section 4.4.1 and 4.4.2, suitable habitat descriptions in Section 4.4, and submitted to CAL FIRE as described in Section 6.0 of this NSORP.

5.0 SURVEYS

A key component of the USFWS guidance (USFWS 2008[b]) is the proximity and arrangement of one suitable habitat type to another. In other words, the spatial relationship between nesting and roosting habitat where owls reproduce and high quality foraging and low quality foraging habitats where owls can roost and forage. Recent research in northern California predicts the probability of Northern spotted owls using specific suitable habitats (Zabel et al. 2003). This study used statistical modeling to identify the location and spatial arrangement of suitable habitat used by Northern spotted owls. Based on radio telemetry data from several study sites in northern California, that are similar to areas covered under this NSORP, the research identified a combination of variables that best explain habitat differences between sites that do or do not support Northern spotted owls. The final model indicated that a combination of nesting and roosting habitat and foraging habitat was a key predictor of occupancy.

Results of other Northern spotted owl habitat studies also indicate a combination of nesting and roosting areas interspersed with foraging areas are beneficial for owls (Farber and Crans 2000, Franklin et al. 2000, Hunter et al. 1995, Irwin et al. 2004, USFWS 2008[b], Zabel et al. 2003). Franklin et al. 2000, found that territory specific owl survival was associated with the amounts of older nesting and roosting habitats and edge foraging habitats within a core use area of 390 acres (0.4 mile circle). Irwin et al. 2010, telemetered owls and found that abiotic conditions and habitat conditions within 400 meters (0.25 mile circle) of nest sites best predicted habitat use.

Based on the results of these studies, WBA has developed a local site-specific method for determining where Northern spotted owls are likely to be detected (USFWS 2011). The local site-specific method concludes that Northern spotted owls are only likely to occur and occupy sites in a landscape when High Quality Nesting and Roosting habitat or Nest and Roosting habitat exists within 0.5 mile of existing Foraging habitat. Accordingly, for operations within 1.3 miles of a known occupied Northern spotted owl activity center or within the Northern spotted owl evaluation area (14 CCR 895.1) or within the USFWS recommend areas to be considered when planning forest management operations (USFWS 2008[a]), a survey will be conducted prior to commencement of forest management activities considering the following:

5.1 Surveys: Silviculture prescriptions that maintain suitable habitat

As previously stated, uneven-aged silvicultural prescriptions such as low intensity individual tree selection and group selection are widely used within WBA managed lands. These low intensity silvicultural practices typically retain mature forest cover, large trees, and other habitat elements important to Northern spotted owls such as large snags, cull trees, hardwoods, and densely forested areas with multiple canopy layers. When suitable habitat exists prior to harvest, and uneven-aged silvicultural prescriptions will retain pre-habitat types (ex. foraging as foraging), survey of suitable habitat will be conducted when the following criteria are met:

(1) If no suitable habitat exists within the THP boundary or within 0.5 miles of the THP boundary, then NSO surveys will not be necessary.

(2) If no suitable habitat exists within the THP boundary, but suitable High Quality Nesting and Roosting or Nesting and Roosting habitat exists within 0.5 miles of the THP boundary, surveys shall be conducted in all suitable High Quality Nesting and Roosting, Nesting and Roosting and Foraging habitat that lies within 0.5 miles from the THP area, that is legally accessible to WBA. If timber harvesting is to occur outside the breeding season of February 1st to August 31st, no surveys shall be necessary or conducted.

(3) If suitable habitat exists within the THP and suitable High Quality Nesting and Roosting or Nesting and Roosting habitat exists within 0.5 miles of the THP boundary, surveys shall be conducted in High Quality Nesting and Roosting, Nesting and Roosting, and Foraging habitat that lies within the THP and within 0.5 miles from the THP area, that is legally accessible to WBA.

5.2 Surveys: Silviculture prescriptions that do not maintain suitable habitat

When suitable habitat exists prior to harvest, and uneven-aged silvicultural prescriptions will not retain suitable habitat or will be degraded (ie. nesting reduced to foraging) immediately following operations, survey of suitable habitat will be conducted when the following criteria are met:

(1) If no suitable habitat exists within the THP boundary or within 1.3 miles of the THP boundary, then NSO surveys will not be necessary.

(2) If no suitable habitat exists within the THP boundary, but suitable High Quality Nesting and Roosting or Nesting and Roosting exists within 1.3 miles of the THP boundary, surveys shall be conducted in the suitable High Quality Nesting and Roosting and Nesting and Roosting, and Foraging habitat that lies within 1.3 miles from the THP boundary, that is legally accessible to WBA. If timber harvesting is to occur outside the breeding season of February 1st to August 31st, no surveys shall be necessary or conducted.

(3) If suitable habitat exists within the THP and suitable High Quality Nesting and Roosting, Nesting and Roosting habitat exists within 1.3 miles of the THP boundary, surveys shall be conducted in High Quality Nesting and Roosting, Nesting and Roosting, and Foraging habitat that lies within the THP boundary and within 1.3 miles from the THP area, that is legally accessible to WBA.

5.3 Modification of USFWS 2011 Protocol: 3-visit surveys

Since listing of NSOs under the federal ESA, protocol surveys have been conducted following guidance provided by the USFWS 1992 protocol (Forsman 1983, USFWS 1992). Based on almost 20 years of surveys and new scientific information regarding detectability of Northern spotted owls (Dugger et al. 2011, Kroll et al. 2010, Olson et al. 2005), the USFWS proposed new guidance in the USFWS 2010 protocol. Subsequently, based on additional new information and public comments the USFWS recommended the USFWS 2011 protocol, an errata and revisions in 2012.

The USFWS 2011 protocols were developed for NSOs over the entire range of the species from California to Washington. Recent research has indicated that the effectiveness of surveys conducted to detect NSOs has been reduced across a wide portion of the species distribution by the occurrence of barred owls (*Strix varia*) which is reflected in the current USFWS 2011 protocol. Based on this research, surveys conducted where barred owls occur more frequently the USFWS has recommended a two-year 6-visit survey.

Recent research in landscapes where barred owls occur in lower densities, in portions of the Southern Cascades and Klamath provinces of California, detection probability of Northern spotted owls using operational surveys can support presence and site status determination at USFWS desired levels of confidence (Farber and Kroll 2012)(Figure1)(Appendix C). In addition, the USFWS Technical Assistance 81333-2011-TA-0027 (USFWS 2011[d]) concurred that a 3-visit survey effort was appropriate for this landscape. The research included both stand-based searches and nighttime station-based surveys. The stand-based searches are informed daytime searches conducted within Northern spotted owl core use areas (Bingham and Noon 1998, Zabel et al. 2003) centered on activity centers. Informed daytime searches are routes developed by biologists using current and historical biological information important in finding owls, which includes: (1) Historic or current location of spotted owl nest and roost sites, (2) Suitable habitat with core areas, (3) Location of previous night and daytime spotted owl detections and, (4) Location of abiotically favored suitable habitats. This information is readily available in WBA managed lands GIS database and is used to develop the informed daytime stand search routes. Recently, the USFWS has recommended informed daytime searches as part of the most current survey protocol (USFWS 2011).

Figure 1

Northern Spotted Owl Detection Probability

Detection probability is the 1-visit probability (p_{ij})(probability matrix below) that a Northern spotted owl is detected when an owl is actually present. The original USFWS (1992) survey protocol assumed a one-visit detection probability of Northern spotted owls was 0.65. Using the probability matrix below, the original USFWS (1992) protocol then recommended a 3-visit survey that would produce a 3-visit confidence interval of 0.97, or in other words, during a 3-visit survey 97 out of 100 times a Northern spotted owl would be detected, if in fact, the owl was present.

Several studies conducted in landscapes with high densities of barred owls, have indicated that detection probability of Northern spotted owls has been reduced by the presence of barred owls (Dugger et al. 2005, Olson et al. 2005, Kroll et al. 2010). In 2010, the USFWS reviewed the results of these studies and proposed that the average 1-visit detection probability, across the entire range of the species, was currently 0.40. Based on this 1-visit detection probability and the probability matrix below, the USFWS (2011) recommended a 6-visit survey that would produce a 6-visit confidence interval of 0.95.

Recently, in the Southern Cascades and Klamath provinces of California, in landscapes where barred owls occur in lower densities, Farber and Kroll (2012) found a current average 1-visit detection probability of 0.67. Based on this 1-visit detection probability and the probability matrix below, Farber and Kroll (2012) recommended a 2-visit night survey in combination with one informed day search that would produce a confidence interval greater than 0.95, the USFWS standard for confidence in determining Northern spotted owl site status.

	p_{ij}								
	0.30	0.35	0.40	0.45	0.50	0.60	0.70	0.80	0.90
No. visits	p_i^*	p_i^*	p_i^*	p_i^*	p_i^*	p_i^*	p_i^*	p_i^*	p_i^*
1	0.30	0.35	0.40	0.45	0.50	0.60	0.70	0.80	0.90
2	0.51	0.58	0.64	0.70	0.75	0.84	0.91	0.96	0.99
3	0.66	0.73	0.78	0.83	0.88	0.94	0.97	0.99	1.00
4	0.76	0.82	0.87	0.91	0.94	0.97	0.99	1.00	1.00
5	0.83	0.88	0.92	0.95	0.97	0.99	1.00	1.00	1.00
6	0.88	0.92	0.95	0.97	0.98	1.00	1.00	1.00	1.00
7	0.92	0.95	0.97	0.98	0.99	1.00	1.00	1.00	1.00
8	0.94	0.97	0.98	0.99	1.00	1.00	1.00	1.00	1.00
9	0.96	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00
10	0.97	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00

Accordingly, conducting one informed daytime stand-based search and two nighttime station-based surveys each year for two years will meet the USFWS standard for confidence (>0.95) in site status (Farber and Kroll 2012). Also, based on this level of detection probability, conducting two informed daytime stand-based searches and three nighttime station-based surveys for one year will meet the USFWS standard for confidence (> 0.95) in site status. The stand-based searches should be focused earlier in the nesting season, either March, April, May or June, although, the month (ie. Julian date) during the nesting season was not a significant variable in improving detection probability (Farber and Kroll 2012).

However, Farber and Kroll (2012) infrequently found 13 barred owls during 1,282 surveys which detected 480 spotted owls. In addition, barred owls were never detected more than once within 0.5 miles of a known spotted owl activity centers. Accordingly, based on the scientific scope of inference for this study, where barred owls are repeatedly detected (more than once) within Northern spotted owl 0.5 mile core use areas, the recommended survey procedures may be less effective in determining presence or absence of NSOs.

In summary, based on the results and recommendations of research conducted within portions of the Southern Cascades and Klamath provinces of California, surveys shall be conducted following the USFWS (2011) protocol with the following modification.

5.4 Modification of USFWS 2011 Protocol: Multiple Season and Single Surveys

For all forest management activities where surveys are required, the following modifications shall be followed for all surveys:

(1) Prior to conducting surveys, all available historic and current Northern spotted owl information shall be reviewed. Information shall include; historic or current location and status of activity centers, suitable habitat maps for activity centers, location of previous detection locations, previous nest and roost locations and location of abiotically favored suitable habitat.

(2) Where a barred owl has been previously detected more than once within an existing occupied Northern spotted owl 0.5 mile core use area the survey shall be conducted following the USFWS (2011) protocol guidance and USFWS Technical Assistance.

(3) Where a barred owl has not been previously detected more than once within an existing occupied Northern spotted owl 0.5 mile core use area the following survey shall be conducted:

  (a) Where a 2-year survey is conducted, each survey year shall include:

    (i) One informed daytime stand-based search of the best abiotic locations of suitable habitat with 0.5 miles of a known occupied activity center. The stand-based search shall be conducted as early in the nesting season, as feasible, in either March, April, May, or June.

(ii) Two nighttime station-based surveys following USFWS (2011) guidance regarding survey station placement and procedures.

(iii) Survey results for a 2-year survey are valid until the beginning of the following breeding season Feb 1st. Years following 2-year survey shall follow USFWS (2011) guidance regarding spot-check surveys.

(b) Where a 1-year survey is conducted, the each survey shall include:

(i) Two informed daytime stand-based search of the best abiotic locations of suitable habitat with 0.5 miles of a known occupied activity center. The stand-based search shall be conducted as early in the nesting season, as feasible, in either March, April, May, or June.

(ii) Three nighttime station-based surveys following USFWS (2011) guidance regarding survey station placement and procedures.

(iii) Survey results for a 1-year survey are valid until the beginning of the following breeding season Feb 1st.

5.5 Modification of USFWS 2011 Protocol: Early Season Determination of Nesting

The USFWS 2011 protocols were developed for NSOs over the entire range of the species from California to Washington. As stated in the USFWS 2011 protocol if surveys commence during the early period of the nesting season (March and April), the protocol requires that 2 visits of a 6-visit survey be conducted during the month of June. Due to interior Northern California's more southern latitude, relative to the entire NSO range (Timber Products Company 2005) and nesting season chronology (Irwin et al. 2004), an additional modification to the USFWS 2011 protocol applies to all surveys conducted under this NSORP.

(1) If barred owls <u>are present</u> as described in Section 5.4 (2) of this NSORP, a 2-year, 6-visit USFWS protocol is required and 2 visits of the 6 visit survey survey shall be conducted after May 15th of the nesting season.

(2) If barred owls <u>are not present</u> as described in Section 5.4 (3a) of this NSORP, and a 2-year survey is conducted, 1 of the 2 nighttime station-based surveys shall be conducted after May 15th of the nesting season.

(3) If barred owls <u>are not present</u> as described in Section 5.4 (3b) of this NSORP, and a 1-year survey is conducted, 1 of the 2 informed daytime stand-based searches and 1 of the 3 nighttime station-based surveys shall be conducted after May 15th of the nesting season.

6.0 TIMBER HARVEST PLAN PREPARATION PROCEDURES

The following reporting procedure for THPs in the NSO evaluation area shall demonstrate that take of NSOs will not occur and has been avoided as per 14 CCR § 939.10. The following information shall be submitted to Cal Fire with the THP or amendment(s) that may impact NSOs to demonstrate that the terms, conditions, and procedures in the NSORP have been followed.

Surveys: If Surveys are Necessary

A survey summary shall be provided with each THP and NSO related amendment, including a map showing all calling stations, the location of all active and historic NSO nests and activity centers within 1.3 miles, the THP boundary, roads (appurtenant, seasonal private, permanent private, seasonal public, permanent public, and temporary), landings, helicopter landings and flight corridors, and the NSO habitat types shall be provided at the time of filing. The highest known status (resident single, pair, nesting,) shall be used to determine if an historical activity center is located within this area. Locations recorded within the database that do not adequately establish a valid activity center will be considered but will not require buffer zones or habitat protection.

The following information shall be provided to Cal Fire at the time of THP submittal in Section III of the THP and in NSO related amendments:

- Map of call stations and current year survey results
- Habitat analysis around all activity centers within 1.3 miles and THP boundary
- Estimates of pre harvest and post-harvest habitat acres within the THP area

Surveys: If Surveys are Not Necessary

For THPs within the NSO Evaluation Area or those areas referenced in the USFWS guidance (Appendix A) a map showing the lack of NSO habitat shall be provided. This map shall show the boundaries of all timber stands that meet the criteria within 0.5 miles of the THP boundary.

THP Measures

When the location of a NSO or activity center dictate the need, the following information shall be provided to Cal Fire at the time of THP filing and also be included in Section II, Item 32 of the THP and in NSO related amendments:

- A list of all applicable THP Measures
- A map showing the THP boundary, nest and roost buffer zones, and any seasonal restrictions

If THP Measures will be applied during any stage of THP implementation, information shall be provided with the THP which demonstrates that the habitat requirements around areas where THP Measures are applied have been or will be met immediately following harvesting. A copy of the Cal Fire NSORP approval letter shall accompany each THP and shall fulfill the requirements of 14 CCR § 939.9(f) and § 939.10.

Amendments

Amendments that if applied could potentially result in an impact to NSOs or NSO habitat but are lacking current NSO information shall be considered not in compliance with the NSORP. Amendments that if applied could potentially result in an impact to NSOs or NSO habitat must include a statement describing any changes to the NSO protection measures included in the original THP. Amendments that if applied could potentially result in an impact to NSOs or NSO habitat and involve changes in yarding, silviculture, acreage, road placement or use, shall be reassessed to ensure that proper buffer zones and restriction areas are identified.

7.0 OTHER CONDITIONS

In each THP conducted pursuant to this NSORP, the California Registered Professional Forester (RPF) must certify that he possesses sufficient knowledge and experience to properly interpret NSO survey results or has consulted with a S.O.E. Conditions which preclude adoption of the THP Measures (Section 4.4) will require USFWS technical assistance and Cal Fire shall be notified at least 30 days prior to operations that could result in take of a NSO. The following baseline information is a prerequisite of this NSORP:

1. Map(s) of WBA managed lands within the NSO Evaluation Area as defined by 14 CCR § 895.1 and those within 0.5 miles of the townships identified by the USFWS Guidance (Technical Assistance 81333-2008-TA-0058 USFWS[a]) including all known NSO activity centers on or within 1.3 miles of those areas (Appendix A)
2. A list of all NSO activity centers on or within 1.3 miles of WBA managed lands that are in the NSO Evaluation Area as defined by 14 CCR § 895.1 or within 1.3 miles of the townships identified by the USFWS Guidance (Technical Assistance 81333-2008-TA-0058 USFWS[a]). This list shall contain a legal description of each activity center and any pertinent information regarding annual status or productivity (Appendix B).

When preparing for timber harvesting operations (THPs, exemptions, emergencies), all appropriate information sources shall be checked to determine whether any NSOs are known to be present in the general vicinity. Appropriate information sources may include: adjacent land managers/owners, the NSO database maintained by DFW, the WBA database, and/or the California Natural Diversity Data Base (CNDDB) maintained by DFW. The THP Measures (Section 4.4) shall be applied around any known activity centers when conducting timber harvesting operations when NSOs are present during the current year as verified by surveys. Currently unoccupied activity centers, as verified by surveys, shall be protected by applying the THP Measures with regard to habitat modification but not auditory disturbance. If the THP Measures will not be applied or will be modified around currently unoccupied activity centers, a USFWS technical assistance shall be required and Cal Fire shall be notified at least 30 days prior to operations.

This NSORP eliminates the need for further consultation with Cal Fire with respect to NSOs provided that all aspects of the NSORP are adhered to as agreed and described above, the THP Measures are applied as described above, and the THP Measures are adopted as an enforceable condition of any THP relying on this NSORP.

Upon request, WBA will provide an opportunity for a Cal Fire and/or USFWS representatives to periodically inspect NSO habitat within project areas. The purpose of these inspections is to coordinate with WBA personnel with respect to the designation of NSO habitat and to evaluate the effectiveness and implementation of agreed upon THP Measures.

8.0 INFORMATION EXCHANGE

WBA shall submit an annual report to Cal Fire by February 1 of each year that this NSORP is in effect. This annual report shall contain:

(1) Summary of survey results including the surveyors name(s) and qualifications in that year. Survey results (positive and negative) shall also be submitted to the DFW for inclusion in the NSO database.

(2) The dates and times of surveys and a map of the areas surveyed including NSO habitat types used to determine survey areas in that year.

(3) Information that summarizes potential impacts to NSOs or NSO habitat from the timber operations that have occurred for THPs filed under this NSORP in that year.

(4) THP maps of all THPs operated under the NSORP in that year.

(5) NSO survey stations, survey results, and NSO detections including NSO observation reports and any information on pair status or productivity in that year.

(6) Maps showing how habitat retention measures associated with activity centers have been met in that year.

This NSORP will become effective upon signature of all parties of this NSORP and shall continue in force and effect until terminated upon 30 days notice by either of the parties. The NSORP may be amended only by mutual written consent of the parties. The contact person for this NSORP representing Cal Fire will be the Forest Practice Manager, Northern Region, 6105 Airport Road, Redding, CA 96002, (530) 224-2481. The contact person representing WBA for this NSORP will be the Chief Forester or Wildlife Biologist, WBA, P.O. Box 990898 Redding, CA 96099-0898, (530) 243-2783. Changes in the contact persons noted above shall be considered minor changes to this agreement and not alter the validity or enforceability of this agreement.

9.0 CONCLUSION

By concurring with Cal Fire on the methods and protection measures outlined, WBA can incorporate a more efficient means of conducting timber harvesting operations, allow for increased efficiency of regulatory agencies, and provide better management for NSOs and other wildlife species. For the NSO, management and take avoidance guidelines are in place, as is a program designed to evaluate their effectiveness. Flexibility within this NSORP allows WBA to modify, and refine our current efforts to manage all the resources on WBA managed lands.

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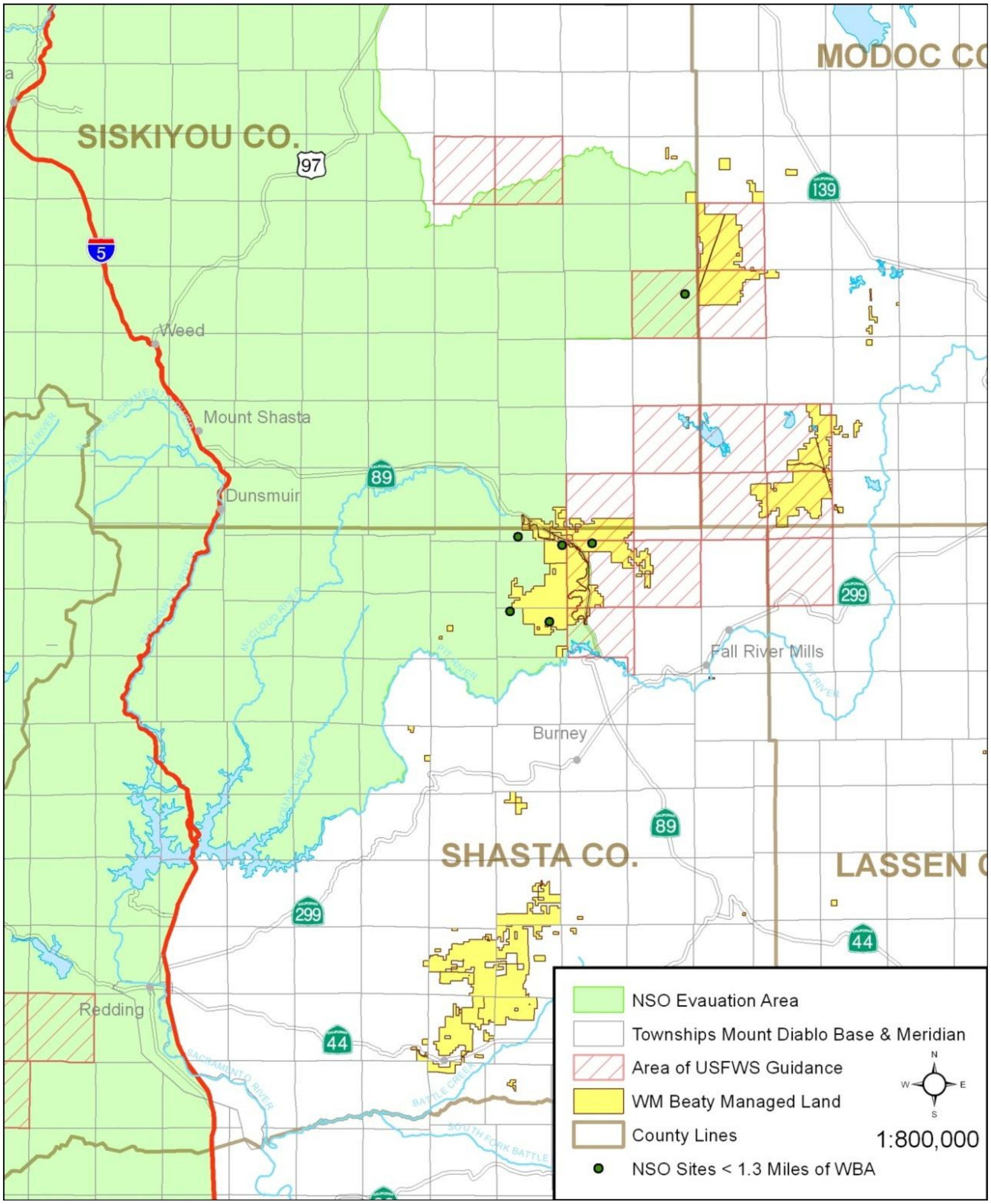
APPENDIX A

Map(s) of WBA managed lands within the NSO Evaluation Area as defined by 14 CCR § 895.1 and those within 0.5 miles of the townships identified by the USFWS Guidance (Technical Assistance Regarding the Southern and Eastern Regulatory Boundaries for the Northern Spotted Owl in California 81333-2008- T A-0058, attached) including all known NSO activity centers on or within 1.3 miles of those areas.



APPENDIX B

A list of all NSO database records depicted areas where detections have occurred on or within 1.3 miles of WBA managed lands that are in the NSO Evaluation Area as defined by 14 CCR § 895.1 or within 1.3 miles of the townships identified by the USFWS Guidance (Technical Assistance Regarding the Southern and Eastern Regulatory Boundaries for the Northern Spotted Owl in California 81333-2008- T A-0058, attached). This list shall contain a legal description of each activity center and any pertinent information regarding annual status or productivity.

Owl Number	Location Name	Owl Number Legal Location (1/64, 1/16, 1/4)	First Year Owl Number Status	Last year NSO Detected at this Location	Survey, Detection, and Activity Center Status
SHA033	Clark Creek	SE, SW, Sec 14, T37N, R2E	Single 1982	Res. Single 1998	5 years of no detection surveys
SHA075	Dickson Flat SW	SW, NE, Sec 1, T38N, R2E	Pair w/ Young 1990	Pair 1991	Declared Unoccupied by CAL FIRE 2013
SHA101	Dickson Flat E	NW, Sec 4, T38N, R3E	Res. Single 1993	Res. Single 1993	Not Valid Activity Center (NVAC) by USFWS and CAL FIRE 2013
SHA113	Rock Creek	SE, SE, Sec 7, T37N, R2E	Single 2001	Single 2008	Not Valid Activity Center (NVAC) by USFWS 11/8/2007
SIS250	Bear Creek W	NW, SE, Sec 32, T39N, R2E	Res. Single 1983	Single 1992	1998 USFWS Consultation NSO#R1308 considers site abandoned.
SIS429	Border Mountain	NW, NE, NE, Sec 14, T42N, R4E	Single 1980	Pair 2013	Nesting pair 2013

APPENDIX C

FORESTLAND MANAGEMENT

W. M. BEATY & ASSOCIATES, INC.

845 BUTTE ST. / P.O. BOX 990898
REDDING, CALIFORNIA 96099-0898
530-243-2783 / FAX 530-243-2900
www.wmbeaty.com

March 11, 2014

VIA E-MAIL

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Nongame Wildlife Program
Attn: Neil Clipperton
1812 9th Street
Sacramento CA 95811

Dear Mr. Clipperton;

Attached are several studies of Northern spotted owl (*Strix occidentalis caurina*) conducted on private forestlands in Siskiyou and Shasta County, California. Also attached is our Northern Spotted Owl Resource Plans (NSORP) that currently directs forest management activities on W.M. Beaty and Associates managed lands. We are providing these studies and management plans to you during your evaluation of a petition to list Northern spotted owl as a threatened or endangered species under the California Endangered Species Act.

Farber, S.L. and A.J. Kroll 2012 Site occupancy dynamics of Northern spotted owls in managed interior Douglas-fir forests, California, USA, 1995-2009. This published manuscript was based on 1,282 individual surveys and 480 spotted owl detections and 13 barred owl detections over 15 years. Average per visit detection probability (95% CL) for single and pair spotted owls was 0.93 (0.90−0.96) for informed daytime, stand-based searches and 0.47 (0.43−0.53) for nighttime, station-based surveys (estimated from the best model); the average per visit detection probability from the null model was 0.67 (0.63−0.70). Results suggest that a combination of 1 informed stand and 2 station-based operational surveys can support determinations of spotted owl site status (either a single or a pair) at desired levels of confidence. However, our information was collected in an area where barred owls were rarely detected. Surveys conducted in areas that support well-established barred owl populations are likely to be less effective for determining presence/absence of spotted owls and may require more surveys and/or different survey methods to determine site status with confidence.

Spotted owl site occupancy probability declined from 0.81 (0.59−0.93) in 1995 to 0.50 (0.36−0.63) in 2009; pair occupancy declined from 0.75 (0.49−0.91) to 0.46 (0.31−0.61). The resulting 39% decline across the 15 years of the study or approximately 2.6% annually slowed in the final 5 years of the study. However, while modeled probabilities declined 2.6% annually, the number of sites declared unoccupied or abandoned during the study period resulted in only a 9% decline across 15 years or approximately 0.6% annually. These actual site occupancy results are consistent with the reported small local-extinction and colonization probabilities which suggest relatively low turn-over at individual owl sites over 15 years.

Irwin, L.L. and D.F. Rock, S.C. Rock 2012 Habitat selection by Northern spotted owls in mixed-conifer forests. This published manuscript was based on radio-telemetry of 71 spotted owls over 5 years in 3 study areas, one in the Southern Cascades of California. Spotted owl habitat selection models were most strongly influenced by abiotic factors with negative relationships with increased distance to nest, distance to stream and positive relationship to slope. In other words, owls disproportionately used habitats within 200-300m of nest sites, closer to streams and on steeper slopes. Also, higher basal area of conifer trees with 400m of nest sites were used disproportionately. Most importantly these abiotic factors were more predictive than variables traditionally use to describe suitable owl habitat like habitat type, size or seral stage. Through adaptive management these understandings are being inserted into Spotted Owl Management Plans (SOMP), Northern Spotted Owl Resource Plans (WBA NSORP 2011), habitat conservation measures and stand-search survey strategies.

Farber, S.L. and J. Whitaker 2005 Diets of Northern spotted owls in the Southern Cascades and Klamath Provinces of interior Northern California. This unpublished study found that in both the eastern Klamath and Southern Cascades provinces Northern spotted owls consume a wide variety of prey including 16 individual species of mammals, 5 species of birds, and 1 species of insect. Based on 339 individual prey items, woodrat sp.(60.6%) followed by Northern flying squirrel (28.2%) biomass were the primary prey species for Northern spotted owls in the eastern Klamath mountains. Woodrat sp. (46.6%) followed by Northern flying squirrel (34.1%) biomass were the primary prey species in the Southern Cascades. No independent variables including tree species, size or density were significant at predicting the percent of flying squirrel biomass for an owl site. Prey species habitat associations indicate that maintaining a variety of habitats within owl sites maybe be beneficial for foraging Northern spotted owls.

W.M. Beaty and Associates, Northern Spotted Owl Resource Plan (NSORP)
This NSORP was originally approved by Cal Fire in 2011 and has subsequently been amended to update the NSORP with the current USFWS protocol, USFWS technical assistance and current scientific findings.

We hope you find the information contained in these studies and management plans interesting and informative. If you have any questions or need any additional information, please contact me at stuf@wmbeaty.com or at (530)243-2783.

Sincerely,

W. M. BEATY & ASSOCIATES, INC.

Stuart Farber
Wildlife Biologist

cc. P. Battaglia

Electronic Attachments: Farber, S.L. and A.J. Kroll, 2012.
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Farber, S.L. and J. Whitaker, 2005.
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From:	Bard Francis
To:	Wildlife Management
Subject:	northern spotted owl resp
Date:	Thursday, January 23, 2014 6:10:56 PM

Greetings from retired USFS wildlife biologist 35 years in service GS-11 retired, MS Zoology, BS forestry, member 30 groups such as audubon, sierra club, FOE, UCS, etc.

I wrote the first spotted owl plans on the STNF in Mt Shasta, CA. Right at the first I saw they were inadequate and protested, but wrote them anyway as ordered by district ranger Showalter, who changed my data without my knowledge. He proceeded to log spotted owl groves, which led to a federal investigation, which led to whistleblowing, which led to my career stagnation and harassment, while District Ranger Showalter was kicked upstair$$$ to the SO in Redding. The following rangers were decidedly unfriendly, which led to more sexual harassment of me and 3 physical beatings of me on station grounds, no DR protection of action taken. The explanation was that I was causing the district timber team to not get their cash productivity awards because of "You and your damned spotted owls, see what you done you bastard!" and that includes collaboration with the district ranger Mike Hupp and Bob Hammond, especially Hupp, who collected $12,254 for logging over a few owls (FOIA).

The point of the above is that the USFS has no incentive at all to protect the NSO (Owl) or any other wildlife that gets in the way of cash awards for selling timber. They will try to get around it as best they can, and as they told me "So whaddya expect us to do now, go glue da trees back onta the stumps? Shaddup and mind yer own buzness!!" and this was the unspoken word as well from the district rangers. For verification, the testimony I gave in Washington DC with AFSEE or FSEE is likely still on the internet and likely they still know me.

If you wish me to go into the biology of it all, I know you know that. The owl is still declining mostly thanks to lackadaisical and incorrect inept tools and rules for timbering, locally at the rate of 5-11% per year. I once had about 28 pairs of owls on this district, now I think maybe under 5 pairs are actually still reproductive, most simply disappeared after we logged them, a few got shot under mysterious circumstances under the tenure of Francis Mangels and Debbie Derby (She would take no sexual harassment from anyone, and threatened liberally, so they turned on me at 5'5"). As ranger Showalter told me directly, "the owls can just go somewhere else, now get out of my office!" With limited habitat, the owls simply died, and I meekly obeyed. The biologists before me left letters on what to expect, and indeed it was worse than they said, eg Becky Provart, Dave W.

The truth is, we just logged away at the spotted owl habitat until it was gone. the timber game was "OOOooops, guess we accidentally logged the wrong hillside, sorry we won't do that again," and collected their logging cash bonus...btw they got about $3000-5000 each and I got $150, the bare minimum. haw haw haw. Then they beat me up and harassed me, especially if they were expecting more money. The district rangers took my written complaint and did nothing, but I saved the documents.

Somebody will likely point out climate collapse, and UCS proves this is true. It is a threat to the NSO and many other species as well, such as pikas, goshawks, martens, fishers, wolverine, etc. Not to mention many of our local common birds are disappearing like *Silent Spring* revisited, by Rachel Carson, worth a reread, but now its global heating.

Something else I fought hard about was cattle grazing effects on NSO. It was so hard that it chewed up much of the prey habitat where the owls did not have flying squirrels. These marginal habitat owls went for a few hamburgers, such as the Toad Mtn owls and all owls in the Eddy Mountains. As a cumulative effect, you ought to discourage and terminate all public grazing within 5 miles of an owl nest, and also pay attention to spotted owl winter range at lower elevations. The NSO does not sit around hibernating, it goes downslope to forest edge pastures and feeds there in the winter. The USFS to its credit did hear me on that one and at least modified NEPA to a "may effect not likely to adversely affect" finding, and the projects went ahead because that finding was still a green light to go for it.

The corridors for owl migration are cut out and gone. The USFS gave lip service to it, but logged it off anyway. Typically, if it was money trees, they took a clearcut-like very heavy thinning out of the middle and terminated the corridors over my protests, thank you Matt Chuela and Ray Haupt, who is now a ranger. Very few biologists made it to DR status, USFS promotes foresters that know how to get the cut out. You might check that ratio. Biologists have little say about the NSO.

Yes, the woods is full of trees, but they are monocultures of small ponderosa pine, not owl habitat. No old growth of quality left. Those marvelous predictions made in the 1950s of how big and fast they would all grow are all falling flat....all failures in prediction and production.

If you wish to find out a bit more on what went on to drive the owl into endangered status, just give me a call at 530-926-0311 in pm and I'll give you more. I'm retired and out of USDA now, but I could see way back in 1985 that things were very inadequate. The entire NSO game was to get the last money trees and march that owl to extinction. Yes, declare it endangered, but at least here on the boundary between Sierra and Coastal habitat owls, that bird is absolutely failing and the corridors for migration are logged out quite effectively by USFS policy and permissiveness of the USFS and BLM administations.

And there's more if you want it.....

Francis Mangels, 736 pine Ridge Ave, Mt Shasta, CA 96067, ph 530-926-0311 in pm ....please acknowledge receipt.

From: Rick Hawks <rickosher@yahoo.com>
Sent: Tuesday, February 04, 2014 10:39 AM
To: Wildlife Management
Subject: Northern Spotted Owl

Hello,
I am sending my comments about the Northern Spotted Owl and others.
I have lived on a 50 acre parcel in Humboldt County for 55 plus years. I have had 2 regular harvest plans and now the NTMP since 1996. I have second growth Redwood and Douglas Fir. I operate on sustained yield and harvest only when the market is up. I am bordered by State Park on 2 sides and Humboldt Redwood on 2 sides.
For 50 years I have known we have and still have Great Horned Owls. For the first 30 years, never Northern Spotted Owls or Barred Owls. For the last 20 years Northern Spotted Owls as transients and for the last 10 years, Barred Owls also.
I have frequently observed all at close range. Observing and listening to Spotted Owls and Barred Owls in the last 10 years confirms that they were silent for the first 30 years. When you live on a rural property, you know the property.
I would safely say that Great Horned Owls are maintaining, Spotted Owls and Barred Owls definitely increasing in numbers.
The worst problem here is pot growers! They are killing and poisoning anything and everything. I have not seen a Pacific Fisher in the wild, only dead ones that Sherrif Mike Downey holds for newspaper pictures, poisoned by pot growers. We won't go into gross stream and land violations by the pot growers. They seem untouchable! I have California Forest Practice Rules, pot growers have none!

Respectfully,
Rick Hawks
rickosher@yahoo.com

From:	John Livingston
To:	Wildlife Management
Subject:	northern spotted owl
Date:	Wednesday, January 29, 2014 5:10:13 PM

As part of your evaluation of the endangered status study of the spotted owl please consider the following comments:

Habitat for NSO is rapidly disappearing from forested areas, especially private timber lands. Many owls have probably been destroyed as there is very limited evaluation of nest sites immediately before logging begins.

I hike extensively in northern California and some areas are NSO habitat. I have heard owls in the past but all wildlife seems to be disappearing, especially all types of birds and bees.

No NSO nests should be destroyed by any permitted take regulation. NSO sites with a suitable buffer should be preserved at all costs. Logging companies care nothing about any wildlife or plants or any part of the ecosystem except wood fiber. Preserving more habitat for NSO on private lands will extend the possible nesting sites and provide habitat for more diversified wildlife.

Large areas of NSO habitat are constantly under attack in the region east and north of Mt. Shasta. Federal and private land managers need to protect all NSO habitat areas and do a better job of evaluating the presence of nesting sites and how to protect them.

Thanks

John Livingston
Chair of Executive Committee
Shasta Group of the Mother Lode Chapter
Sierra Club
2378 Waldon Street
Redding, CA 96001

From: McCain, Rachel <rachel_mccain@nps.gov>
Sent: Thursday, May 01, 2014 4:13 PM
To: Wildlife Management
Cc: Kristin Schmidt
Subject: Fwd: Northern Spotted Owl - Redwood National and State Parks comments/information
Attachments: RNSP to CDFW_nso comments_050114.pdf; 2012_SPOW_Report_Redwood.pdf

Please see the attached files. Hard copies were mailed to Sacramento.

--
Rachel McCain
Superintendents' Secretary
Redwood National and State Parks
1111 Second Street, Office #1
Crescent City, CA 95531
Office: 707.465.7301
Cell: 707.498.4080
Fax: 707.464.1812

United States Department of the Interior
California Department of Parks and Recreation
Redwood National and State Parks
1111 Second Street
Crescent City, California 95531

N1621 (Northern Spotted Owl)

May 1, 2014

Neil Clipperton
California Department of Fish and Wildlife
Nongame Wildlife Program
1812 9th Street
Sacramento, California 95811

Re: California Department of Fish and Wildlife's Status Review of the Northern Spotted Owl

Dear Mr. Clipperton:

Enclosed please find the *Northern Spotted Owl Monitoring and Inventory, Redwood National and State Parks, 2012 Annual Report,* the most recent report on file. This report summarizes what we believe to be the current status of the northern spotted owl in the parks. The dominant *Strix* species residing in the parks is now the barred owl (*Strix varia*).

Although the 2013 annual report has not yet been written, we can tell you that out of 13 sites surveyed (historic spotted owl activity centers or project areas) in 2013, spotted owls were detected in 2 of the sites and barred owls were detected in the remaining 11 sites. Barred owls continue to be a factor in our ability to detect spotted owls within the parks, assuming those historic sites are still occupied, which appears to be unlikely.

Thank you for considering this information.

Sincerely,

Stephen Prokop
NPS Superintendent

Jeff Bomke
CDPR Sector Manager

Redwood
National and State Parks

National Park Service
U.S. Department of the Interior

California State Parks
Department of Parks & Recreation

NORTHERN SPOTTED OWL MONITORING AND INVENTORY REDWOOD NATIONAL AND STATE PARKS 2012 ANNUAL REPORT

April 16, 2013

ACKNOWLEDGMENTS

The spotted owl monitoring and inventory program at Redwood National and State Parks (RNSP) is dependent upon the dedication of many hardworking field technicians, volunteers, and biologists. Specifically, thanks go to seasonal biological technicians Joanna DiTommaso, Susannah Manning, Alder Gustafson, Tony Kurz, and Jesse Sargent, for their excellent fieldwork. Permanent NPS staff biological technicians Kyle Max and Heather Brown provided leadership in the field and with data collection. Kyle and Heather also entered and proofed both this season's and past seasons' data and created field maps. Terry Hines, NPS supervisory biological technician, and Amber Transou, CSP staff environmental scientist, provided quality oversight to the field effort; Terry also has been instrumental in processing data from the original parks' spotted owl inventory. Trevor Bence and Nick Kelly, from Green Diamond Resource Company, assisted with surveying a spotted owl territory that RNSP and Green Diamond "share" inside the national park. Thanks go to Judy Wartella, RNSP GIS Specialist, for her assistance with database management and GIS coverage for both spotted owls and barred owls.

EXECUTIVE SUMMARY

Annual monitoring of known northern spotted owl (*Strix occidentalis caurina*) activity centers in Redwood National and State Parks (RNSP) continued in 2012, at a reduced level. Project-level, or "compliance", surveys also were conducted for a forest restoration project and annual maintenance sites. The goals of the spotted owl program in RNSP are to:

> Determine the status of the parks' spotted owl population (occupancy trends);
>
> Provide information that will contribute to the overall knowledge base regarding the recovery of the sub-species;
>
> Document the presence of barred owls (*Strix varia*) and where possible determine social and reproductive status of barred owl territories;
>
> Protect spotted owls from harassment or harm that could be caused by park operations taking place during the breeding season.

In recent years, as more and more spotted owl territories appear to have been abandoned, likely due to the rapid increase in barred owls within their territories, the spotted owl monitoring program in the parks has tapered off. Many of the historic activity centers and surrounding home ranges are in locations that now involve much time and effort to survey. Therefore, the parks' occupancy data currently are incomplete, that is, we cannot definitely say how many of the historic sites are currently occupied/unoccupied. However, based on the many consecutive years of negative survey results, coupled with the persistent presence of barred owls, we believe it is likely that spotted owl occupancy rates within RNSP are currently very low.

Five spotted owl activity centers that were monitored in 2012 had the potential of being "active" (defined as being occupied by one or more spotted owls within the previous three years); 2 others that were inactive also were monitored in 2012. Six of the activity centers were surveyed to protocol. Monitoring of these territories primarily focused on the 0.25-mile core area around each activity center. No home range inventories were conducted in 2012.

Four territories in RNSP were occupied by spotted owls in 2012; three were occupied by single females and one by a single male.

Compliance surveys for one project site and four annual maintenance site using 47 pre-established call points were conducted. No spotted owls were detected during compliance surveys, however, barred owls were detected at a number of locations.

If a barred owl was detected during a survey, a limited effort was made to determine its occupancy and reproductive status. There were 17 barred owl detections at 10 sites which represented at least 17 individuals. There was one new barred owl site documented in 2012. Barred owls continued to be a factor influencing spotted owl presence and detectability in the parks.

INTRODUCTION

The goals of the northern spotted owl (*Strix occidentalis caurina*) monitoring and inventory program in Redwood National and State Parks (RNSP or "parks") historically were to:

Monitor a portion of the parks' spotted owl population to provide information on occupancy;

Provide information that will contribute to the overall knowledge-base regarding the recovery of the subspecies;

Document the presence of barred owls (*Strix varia*) and where possible determine social and reproductive status of barred owl territories;

Protect spotted owls from harassment or harm that could be caused by park operations taking place during the breeding season.

In recent years, as more and more spotted owl territories appear to have been abandoned, likely due to the rapid increase in barred owls within their territories, the spotted owl monitoring program in the parks has tapered off. Many of the historic activity centers and surrounding home ranges are in locations that now involve much time and effort to survey. This is due to the remoteness of many of the sites in rugged terrain, where there is no longer road access due to watershed restoration activities, or because of failure of abandoned logging roads. Therefore, the parks' occupancy data currently are incomplete, that is, we cannot definitely say how many of the historic sites are currently occupied/unoccupied. However, based on the many consecutive years of negative survey results, coupled with the persistent presence of barred owls, we believe it is likely that spotted owl occupancy rates within RNSP are currently very low.

Not conducting routine monitoring of a large portion of historic sites reduces the parks' ability to inform the overall knowledge-base regarding recovery of the subspecies. We continue to document the presence of barred owls and in late 2012 conducted a mapping exercise to determine, to the best extent practicable, the approximate number of unique barred owl sites within the parks. Over time we increasingly are keeping track of barred owls, as that is the species most often detected by our spotted owl surveys when and where they occur.

We are continuing to conduct "compliance" surveys in project areas where park operations take place during the breeding season to ensure that we are not causing harassment to spotted owls that may have gone previously undetected, or are in the vicinity of known spotted owl activity centers whether active or inactive.

The original spotted owl inventory work conducted in 1993 through 1995 identified at least 37 and perhaps as many as 40 spotted owl activity centers in RNSP (Tanner 1999). An additional 3 sites in the Mill Creek addition to Del Norte Coast Redwoods State Park also were added to the parks' database/ monitoring program beginning in 2003. During the original inventory, as many spotted owls as possible were captured, fitted with U.S. Fish and Wildlife Service number bands, and uniquely color-banded. Since 1995, banding of adult spotted owls has continued sporadically, with attempts made to band owls residing in those territories that are in the

Redwood Creek watershed, particularly those in close proximity to the boundary with Green Diamond Resource Company commercial timberlands. Also, attempts are made to capture juvenile spotted owls in the parks and band them with young of the year (cohort) bands. Banded cohorts that are located in the parks are recaptured and fitted with adult color bands whenever possible.

In 2012, seven spotted owl activity centers were monitored in RNSP. Five had the potential of being "active" (defined as being occupied by one or more spotted owls within the previous 3 years); the other 2 sites were considered "inactive" (no spotted owls detected within the previous 3 years).

Each year from 1996 through 2001, most or all of the parks' owl activity centers were monitored to assess occupancy and reproductive status. Because of the relatively large proportion of activity centers that were inactive, in 2002 we began conducting territory-wide inventories. This involved a survey of all suitable nesting and roosting habitat within a 1.0 mi-radius circle centered on the historic activity center. The purpose of this broader inventory was to determine whether the spotted owls moved outside the core area (e.g., beyond ~ 0.25 mi from the historic activity center) or had abandoned the territory.

Home range inventories were completed to the previous version of the 2-year survey protocol (USFWS 1992, RNSP 2003) in 20 territories scattered throughout the parks (see Appendix A). The results indicated that 15 of the inventoried territories were no longer occupied by spotted owls, *based on the lack of response of spotted owls using the now obsolete protocol.* Barred owls were detected in 19 of the 20 inventoried territories. The most recent home range inventories were completed in 2009; no new inventories have been started since then, primarily due to the difficulty with accessing the remaining inactive sites.

Project-level surveys, begun in 1998 under the annual maintenance program, of RNSP roads, trails, and campgrounds (referred to as "compliance surveys"), were conducted in 2012. These surveys are done to avoid disturbance to nesting spotted owls from noise generated by RNSP maintenance operations. Compliance surveys are conducted in north and south areas of RNSP in alternate years.

One other proposed project, Lost Man Creek Forest Restoration Phase 2, was surveyed to the standards in the revised protocol (USFWS 2011) for the second year. Davison Road, not considered a "project" under routine maintenance, was surveyed for informational purposes only.

In 2012, we continued to collect data relative to barred owls detected during spotted owl surveys. Although no follow-up or reproductive status visits were done specifically for barred owls, all relevant data were recorded and entered into a database including sex, and social and reproductive status, if determined.

SPOTTED OWL HABITAT WITHIN REDWOOD NATIONAL AND STATE PARKS

There are approximately 97,000 ac (39,000 ha) of forested land in Redwood National Park and Prairie Creek Redwoods, Del Norte Coast Redwoods, and Jedediah Smith Redwoods State Parks in northwestern coastal California (Fig. 1). Elevations range from sea level to about 3,100 ft (945 m) within RNSP. Forested terrain is primarily steep, rugged, and covered with dense vegetation. Extreme seasonal temperature variations are rare; annual temperatures range from an average of 45°F (7.2°C) in winter to an average of 69°F (20.5°C) in summer. Average rainfall is 69” (175 cm) per year. Redwood National and State Parks lie within a temperate rain forest ecosystem strongly influenced by coastal fog.

The forests within RNSP are dominated by coast redwood (*Sequoia sempervirens*) and Sitka spruce (*Picea sitchensis*). Other common tree species include Douglas-fir (*Pseudotsuga menziesii*), tanoak (*Lithocarpus densiflorus*), western hemlock (*Tsuga heterophylla*), grand fir (*Abies grandis)*, and red alder (*Alnus rubra*). White oak (*Quercus garryana*), black oak (*Q. kelloggii*) and Douglas-fir dominate upstream areas in Redwood Creek toward the southeast boundary of the national park. There are approximately 9,000 ac (3,600 ha) of non-forested habitats within RNSP including coastal scrub, coastal prairie, and inland prairie.

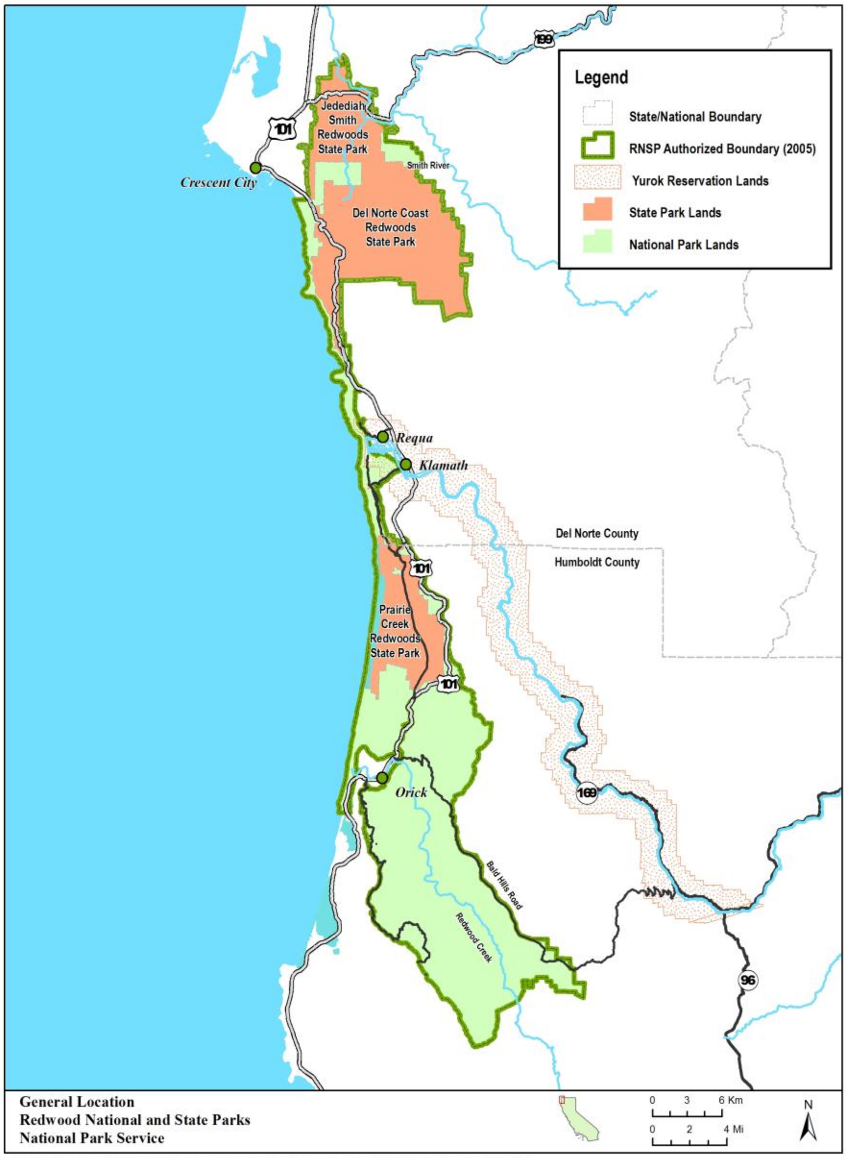

Figure 1. Redwood National and State Parks general location.

Within RNSP there are 41,071 ac (16,621 ha) of old growth forest, all of which is considered suitable spotted owl nesting, roosting, and foraging habitat. Prior to Redwood National Park's establishment and expansion, and addition of the former Stimson Lumber Company land to Del Norte Coast Redwoods State Park, timber harvest occurred in old growth stands on land that is now within the parks. More than 75,000 ac (30,300 ha) were harvested, primarily in the national park and the former Stimson land, using seed tree retention and clearcut harvest prescriptions. These stands are now between 15 and 100 yrs old. As of 2012, there were 43,277 ac (17,514 ha) of second growth forest ≥40 years old that may be considered suitable for nesting and roosting by spotted owls. Forested stands <40 yrs old may be currently suitable for spotted owls where they contain residual old growth trees in sufficient numbers to provide the stand structure requisite for nesting and roosting habitat (RNSP unpub. data). There are an estimated 330 ac (133 ha) in RNSP with residual old growth that are assumed to be suitable for spotted owls. Some unknown proportion of the remaining second growth may be suitable foraging habitat (Gutierrez and Meyer 1993, USDI and CDPR 1999).

METHODS

Monitoring Known Activity Centers

Spotted owl activity centers (ACs) were monitored in 2012 to determine occupancy, partially following the 2011 U.S. Fish and Wildlife Service endorsed protocol, and partially using the old protocols (USFWS 1992, RNSP 2003). Either nighttime surveys or late afternoon/evening or early morning walk-ins were conducted to determine spotted owl presence/absence at an AC. The calling method (use of electronic digital callers) and time spent at each survey station followed the 2011 protocol, but the total number of visits in one case did not. If either a spotted owl or barred owl responded, a bearing in the direction of the response was taken, and an attempt was made to visually locate the owl(s). Sex and age were determined, if possible, for each spotted owl detected and color bands were read if present. Once visual contact was made with one or more owls, surveyors used standard “mousing” techniques (USFWS 1992) to determine nesting or reproductive status. Owl locations were documented with a global positioning system (GPS) unit in NAD 83 X-Y coordinates.

If great horned owls (*Bubo virginianus*), red-tailed hawks (*Buteo jamaicensis*), or other spotted owl predators responded or were otherwise detected, the predator’s location was recorded and the survey ended for that outing.

Surveys were not conducted during heavy rain or when wind speeds were greater than 15 mph. Field data forms were checked and the data were entered into a Microsoft Access database.

Pertinent information regarding spotted owl and barred owl occupancy, and spotted owl reproductive status was summarized for all the years in which surveys have occurred in RNSP.

Compliance Surveys

Surveys using established call points were conducted according to protocol (USFWS 2011a) at 5 project sites. Field methods for compliance were the same as those described above for monitoring activity centers and home range inventories.

Barred Owl Information

As much information as possible (without risking disturbance to spotted owls), was recorded in the same manner for barred owls as for spotted owls. This information included sex, UTM X-Y coordinates of the owl’s location, and social and reproductive status by observing barred owl behavior whenever possible, however, barred owls were rarely moused.

A barred owl "site" in RNSP is defined as a location where one or more barred owls were detected on ≥2 occasions. Unless the survey data (or data from a prior radio telemetry project) indicated a need to do otherwise, clusters of barred owl detections were designated within a site, and separated from adjacent sites by a minimum of a 1.0 mi (1.6 km) radius centered on the site center. Although this is slightly more than the 0.86 mi (1.38 km) average home range radius described by Hamer (1988) for barred owls in Washington and the 0.89 mi radius (1.43 km) used by Kelly et al. (2003) for barred owls in Oregon, it was chosen as an efficient, albeit, conservative "rule" for designating sites in RNSP. This greater distance also was based on evidence indicating there are fewer barred owls in California than in Oregon and Washington (Courtney et al. 2004). Sites were designated less than 1.0 mi from each other if there was definitive evidence of multiple sites in an area. Site "centers" were designated for each site in a manner similar to activity center designations for spotted owls, e.g., a nest tree, young location, or the most recent daytime pair location.

Incidental Observations

We received a couple of reports by other parks' staff or visitors of some type of "Strix" either heard or seen. Survey crews followed up on these incidental observations as soon as possible after learning of the report.

RESULTS

Area Surveyed in 2012

A total of 4,604 ac (1,863 ha), or 5.4%, of the suitable spotted owl nesting and roosting habitat in RNSP was surveyed in 2012 by resource staff in association with monitoring and compliance. Of the area surveyed 1,692 ac (685 ha) were in old growth**,** 2,859 ac (1,157 ha) were in suitable second growth habitat, and 53 ac (21 ha) of residual old growth habitat were surveyed. In addition, there were 586 ac (237 ha) of potentially suitable foraging habitat included in the area surveyed.

Monitoring Known Spotted Owl Activity Centers

Survey Effort

Visits to the 7 ACs took place between April 9 and August 30, 2012. There were 2 complete visits (USFWS 1992, RNSP 2003, USFWS 2011) to 1 AC; 3 complete visits to 1 AC; 4 complete visits to 1 AC; and 6 complete visits to 4 ACs. In total, there were 33 complete visits to spotted owl territories in RNSP in 2012. A total of 81 person-hrs were spent conducting monitoring visits.

2012 Monitoring Results

Of the 7 territories surveyed, 3 were occupied by single females (Coyote Creek, Coyote Rock, and George's Saddle), and one (Paragon) was occupied by a single male spotted owl. The

George's Saddle female was detected once, on February 17, and not again during the rest of the breeding season. The female at Coyote Creek was a new bird based on her color band; the females at Coyote Rock and George's Saddle were the same birds that have been there for the past several years, also based on their color bands.

Miller Creek, which historically has been occupied by both spotted and barred owls, and was the last territory in RNSP known to have successfully reproduced, was not occupied by either species in 2012.

Of the territories surveyed, 3 were occupied by a pair of barred owls (East Side Trail, Kelly Creek, and George's Saddle; see Appendix B).

<u>Compliance Surveys</u>

Survey Effort and Results

Project-level surveys were conducted at one project site, the Lost Man Creek Forest Restoration Phase 2 project, between April 17 and August 14. Thirteen call points were visited 6 times each. Compliance surveys also were conducted at routine maintenance project sites-, 2 trails, 1 road, and 1 facility, using a total of 35 call points. All were surveyed to the standards in the 2011 USFWS-endorsed protocol. In total, 102 person-hrs were spent conducting 30 site-visits for compliance surveys. One owl believed to have been a "sparred" owl (spotted owl- barred owl hybrid) was detected along Howland Hill Road. Barred owls were detected in 6 separate locations, including one in close proximity to the location of the "sparred" owl.

<u>Miscellaneous Surveys</u>

Survey Effort and Results

In 2012, we surveyed the entire length of Davison Road, between Elk Meadow and the Gold Bluffs Beach kiosk, as this area had not been surveyed in many years. It was surveyed 6 times to protocol; a single barred owl and an unidentified *Strix* were detected. Staff also followed up on a report of a *Strix* pair in the Prairie Creek Campground. These birds were not detected during any of 3 visits. Staff also followed up on a belated report of a spotted owl detected in the vicinity of Elk Valley in 2011 by a Klamath Inventory and Monitoring bird surveyor. Two attempts were made to find this owl, without success. In total, 23 person-hrs were spent conducting these miscellaneous surveys.

<u>Barred Owls</u>

There were 17 barred owl detections (a pair equaling one detection) at 10 different sites in 2012 in association with spotted owl surveys, including one on Green Diamond Resource Company land east of the park. These observations represented a total of at least 17 individuals. Three pairs were detected in the course of monitoring spotted owl ACs, and the remainder were detected during compliance surveys (3 pairs, one with a juvenile, and 4 singles). All but one of the barred owls detected in 2012 were in previously known barred owl sites. The one new site consisted of a single barred owl (plus an unknown *Strix* likely to have been a barred owl) detected at the west end of Davison Road. Barred owl pairs were detected in 3 historic spotted owl ACs (East Side Trail, Kelly Creek and George's Saddle).

A thorough evaluation of all barred owl detections dating back to the original inventory in 1993 was conducted to best estimate the potential numbers of barred owl territories within the parks. This exercise resulted in an estimated total of 58 barred owl sites not including those areas with single detections.

DISCUSSION

The objectives of determining the status of the parks' spotted owl population and gathering information that will enhance recovery of the subspecies are becoming more problematic and difficult to achieve due to the presence of barred owls. If no response means spotted owls are no longer occupying their former territories (perhaps a questionable assumption given recent studies, e.g., Olson et al. 2005, Crozier et al. 2006, Diller and Dumbacher 2011) then the status of the parks' spotted owl population is bleak. Without conducting actual barred owl surveys, surveyors or others documented the presence of barred owls at 10 sites in 2012, and determined social and/or reproductive status at 7 of these sites. Using the 1-mile spacing criterion as a guide for determining separate territories, as of 2012 we have documented what may be as many as 58 independent barred owl sites, not including one-time only observations. Many of the barred owl sites have been "surveyed" during multiple field seasons, however, current occupancy status is not known for others that have not been recently visited.

Recent research completed in Washington and Oregon (Singleton et al. 2010, Wiens et al. 2011) investigated barred owl behavior in response to a variety of barred and spotted owl calls, detection probabilities, and landscape occupancy patterns. These studies showed dense-packing of barred owls to an extent previously unknown, with spotted owl home ranges 8 times larger than barred owl home ranges in Washington (Singleton et al. 2010). Wiens (2012) estimated home ranges of spotted owls in central Oregon to be 2-5 times larger than those estimated for barred owls. If a barred owl was present within a spotted owl home range the spotted owl increased its use of space, thus further expanding its home range. Furthermore, in the central Oregon study area barred owls nested more often, had fewer nest failures and produced over 6 times as many young as spotted owls. Over a 3-year study period spotted owls produced 13 fledglings at 15 territories while barred owls produced 80 fledglings at 20 territories. Spotted owls never successfully reproduced when attempting to nest within 1.5 km (0.9 mi) of a barred owl site (Wiens 2012).

Although similar data for California are lacking, there is some evidence that barred owl numbers are increasing in California (Diller and Dumbacher 2011, M. Higley, pers. comm.). In RNSP, spotted owls were detected at just 4 territories in 2012, two at the very southeast end of the national park in the Coyote Creek area, where barred owls have yet to be detected, and in Mill Creek (Del Norte Coast Redwoods State Park). A single female spotted owl belonging to the radio-tagged George's Saddle pair was detected on February 17. This bird was not detected again in the course of surveys during the breeding season.

Data from the 20 inventoried home ranges indicate that spotted owls are no longer occupying as many as 18 (90%) of the territories inventoried (see Appendix A). Barred owls have moved into 19 of these territories, only 5 of which also had spotted owls somewhere in the home range circle. However, subsequent visits to 2 of these territories have again failed to relocate the spotted owls in three consecutive years. There was no known spotted owl reproduction for the second consecutive year in RNSP.

RECOMMENDATIONS/ FUTURE PLANS

It is uncertain whether forest restoration in second growth habitat within the parks will benefit the spotted owl by providing increased nesting and roosting habitat, or if these improved stands also will become home to barred owls. However, the revised spotted owl recovery plan (USFWS 2011b) and proposed revised spotted owl critical habitat (Federal Register 2012) both recommend increasing the amount of suitable spotted owl habitat through forest restoration projects designed to restore natural ecological processes.

There are 5 inactive spotted owl territories that have yet to be inventoried. Unfortunately, all of these sites are in areas with minimal access (roads that were in place when the site was originally found have since been removed). Although it would be very energy-intensive it would be best to attempt to inventory these remaining territories. A re-inventory of all accessible habitat in the parks should take place using the revised USFWS-endorsed spotted owl protocol to determine whether spotted owls have moved into formerly unoccupied areas, or have re-occupied historic sites, and whether barred owls have moved in or are still occupying known sites. A grant from the US Fish and Wildlife Service allowed us to purchase 5 remote digital acoustic listening devices to help determine if spotted owls are still present at recently occupied sites, but hooting only infrequently.

It’s hoped that proposed research involving a barred owl removal experiment (USFWS 2012) will shed light on whether spotted owls would re-occupy former territories in RNSP if barred owls were removed or if some other factor is preventing the parks’ spotted owl population from recovering.

The Redwood Region spotted owl/barred owl resource selection study, that took place in part in RNSP, will inform us as to the degree of habitat partitioning that may occur between the 2 species. Results of this study are in process of being analyzed.

Prepared by: Kristin Schmidt, Wildlife Biologist, Redwood National and State Parks, Orick, CA

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PERSONAL COMMUNICATION

Mark Higley, Wildlife Biologist, Hoopa Tribe, Hoopa, CA

Appendix A. Summary of territories with inactive ACs that were inventoried (all suitable nesting/roosting habitat surveyed within a 1.0 mi radius circle centered on the historic AC).

Territory	Old Growth Habitat Acres	>40 Year 2nd Growth Habitat Acres	Total Nesting/ Roosting Habitat Acres in 1.0 Mile Circle (%)[1]	Years Inventor-ied	Spotted Owl Presence in Years Surveyed	Barred Owl Presence in Years Surveyed
Cedar Creek	1,414	37	1,451 (72.5)	2002/2003	No	Yes- Pair with young
Damnation Creek	1,394	133	1,527 (76.3)	2002/2003	No	Yes
Elam Creek (2)	566	18	584 (29.2)	2002/2003	No	No
Leah Creek (2)	1,671	0	1,671 (83.6)	2002	No spotted owls- not surveyed in 2003 due to barred owl saturation of territory in 2002.	
McArthur Creek 3	15	334	353 (17.6)	2002/2003	No	Yes
Richardson Creek	426	219	645 (32.2)	2002/2003	No	Yes
So. Fork Little Lost Man	1,586	272	1,868 (93.4)	2002	Yes	Yes
Brown Creek	936	107	1,043 (52.1)	2003/2004	No	Yes- Pair
Cole Creek (3)	693	472	1,168 (58.4)	2003/2004	No	Yes
Miller Creek (3)	765	436	1,203 (60.2)	2003	Yes	Yes- Pair
Forty-four (4) Creek	149	1,182	1,331 (65.5)	2004/2005	No	Yes
Home Creek	1,901	67	1,968 (98.4)	2004/2005	No	Yes
Skunk Cabbage	712	445	1,157 (57.8)	2004/2005	No	Yes- Pair with young
McArthur Creek 1 (5)	997	128	1,125 (56.0)	2005/2006	No	Yes
Tom (4) MacDonald Creek	473	1,263	1,763 (86.4)	2005/2006	Yes	Yes
Hatchery Hill	957	210	1,167 (58.3)	2006/2007	No	Yes
McArthur Creek 2 (5)	204	253	457 (22.9)	2006/2007	No	Yes
Bridge Creek 1 (6)	285	898	1,183 (59.1)	2008/2009	No	Yes
Bridge Creek 2 (6)	468	592	1,060 (53.0)	2008/2009	Yes- '08 No- '09	Yes
Bridge Creek 3 (6)	681	866	1,547 (77.3)	2008/2009	Yes- '08 No- '09	Yes

[1] Four territories have less than the entire 1.0 mi radius home range within the park: Cedar Ck (83.0%), Richardson Ck (62.9%), Brown Creek (65.0%), and McArthur Creek 3 (76.8%).
(2), (3), (4), (5), (6) Territories overlap and acres of suitable habitat are shared.

Appendix B. Summary of territories surveyed in 2012 in Redwood National and State Parks.

Territory Name	***Activity Center Status in 2012***	***Best Historical Status (SPOW)***	***"Best" Spotted Owl Status in the period 2008-2012***
Coyote Creek	Pair- nest failed	Reproductive Pair	Pair w/ 1 fledgling
Coyote Rock	Single female	Reproductive Pair	Pair
East Side Trail	Vacant- barred owl pair	Pair	Vacant- barred owl pair
George's Saddle	Single female	Reproductive Pair	Pair w/ 1 fledgling
Kelly Creek	Vacant- barred owl pair	Pair	Vacant
Miller Creek	Vacant	Reproductive Pair	Nest w/ 1 young
Paragon	Single male	Reproductive Pair	Single male

United States Department of the Interior
California Department of Parks and Recreation
Redwood National and State Parks
1111 Second Street
Crescent City, California 95531

N1621 (Northern Spotted Owl)

May 1, 2014

Neil Clipperton
California Department of Fish and Wildlife
Nongame Wildlife Program
1812 9th Street
Sacramento, California 95811

Re: California Department of Fish and Wildlife's Status Review of the Northern Spotted Owl

Dear Mr. Clipperton:

Enclosed please find the *Northern Spotted Owl Monitoring and Inventory, Redwood National and State Parks, 2012 Annual Report,* the most recent report on file. This report summarizes what we believe to be the current status of the northern spotted owl in the parks. The dominant *Strix* species residing in the parks is now the barred owl (*Strix varia*).

Although the 2013 annual report has not yet been written, we can tell you that out of 13 sites surveyed (historic spotted owl activity centers or project areas) in 2013, spotted owls were detected in 2 of the sites and barred owls were detected in the remaining 11 sites. Barred owls continue to be a factor in our ability to detect spotted owls within the parks, assuming those historic sites are still occupied, which appears to be unlikely.

Thank you for considering this information.

Sincerely,

Stephen Prokop
NPS Superintendent

Jeff Bomke
CDPR Sector Manager

From: Angela Rex
To: Wildlife Management
Subject: Northern Spotted Owl
Date: Wednesday, January 22, 2014 4:28:55 PM

I am writing in regards to the proposed listing of the Northern Spotted Owl as a threatened or endangered species.

I am a Biological Research Assistant, and I have worked with Northern Spotted Owls for 8 years. I have looked at the data for the study I am currently on, and it is alarming how apparent the drop in occupied territories and the overal population is. I do not know of any biologist who has worked with Northern Spotted Owls who isn't greatly concerned with the outlook for this species.

Northern Spotted Owls face a steep road to recovery, with habitat loss, changes in forest stand characteristics due to both logging practices and fire supression, Barred Owl competition/aggresion, and what the recent Fisher studies have indicated - possible poisoning from anti-coagulants being used on public (and private) lands around marijuana grows.

Having spoken with some of the biologists who just came from the meta-analysis, the news was far from encouraging. I hope that when you take a look at this data you will see the need for listing the Northern Spotted Owl.

~Angela

United States Department of the Interior
California Department of Parks and Recreation
Redwood National and State Parks
1111 Second Street
Crescent City, California 95531

N1621 (Northern Spotted Owl)

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Sincerely,

Stephen Prokop
NPS Superintendent

Jeff Bomke
CDPR Sector Manager

May 1, 2014

California Department of Fish and Wildlife
Nongame Wildlife Program
Attn: Neil Clipperton
1812 Ninth Street
Sacramento, CA 95811

RE: REJECT THE PETITION TO LIST THE NORTHERN SPOTTED OWL (NSO) AS A THREATENED SPECIES UNDER THE CALIFORNIA ENDANGERED SPECIES ACT (CESA)

Dear Neil Clipperton:

Pursuant to the Calif. Dept. of Fish and Wildlife (DFW) mandate to conduct a status review of species listed as a candidate under Section 2074.6 of the Calif. Fish and Game Code, the undersigned organizations hereby request that the DFW consider the following relevant issues, which we believe support a conclusion that the petition to list the Northern spotted owl (*Strix occidentalis caurina*) as a threatened species under the California Endangered Species Act (CESA) should be rejected.

After reviewing the petition's limited, and in some cases misleading information regarding population trend, range, distribution, abundance, life history and other relevant factors affecting the ability of the NSO population to survive and reproduce, and in consideration of the new population information, we have concluded that the information contained in the petition is not sufficient to indicate that the petitioned action may be warranted, and that the petition should be rejected by the Calif. Fish & Game Commission.

We cite the following justification for the rejection of the petition:

<u>The petition, as presented, lacks any relevant information on NSO population, population trends or habitat requirements</u>. DFW's Evaluation Report cites the minimum requirements for a listing petition pursuant to Fish and Game Code 2072.3. These include "...information regarding the population trend" and "information regarding the kind of habitat necessary for the species survival." As pointed out in the Evaluation Report, this information is either missing or grossly misrepresented. As stated in this Report:

- "The Petition does not assess the species' current population trend in California specifically."
- "The California map is not current and shows northern spotted owl distribution based on CDFG data dated February, 1996."
- "The Petition (pages 12-15) does not include direct information on the abundance of northern spotted owl populations in California, nor does it discuss abundance range-wide."
- "Based on information in the Petition and other data that is readily available to the Department for California, there is uncertainty about whether the declining population trends from specific study areas has translated into an overall decrease in abundance of northern spotted owls in California."

- "The Petition does not specifically summarize the factors affecting the ability of northern spotted owl populations to survive and reproduce in California or range-wide."
- "The Petition describes habitat loss and decline of preferred prey species range-wide, but does not focus on California habitats or prey species..."

The Evaluation Report cites other glaring deficiencies in the petition, including the use of very small sample areas to project population trends, the use of out-dated population data, and reference data provided to DFW that was in an unusable format.

NSO distribution and population data for California indicate a healthy, stable and dynamic population and an increasing known occupied habitat. Using recent and historic data from DFW's NSO database, the population of NSO pair territories has been steady, or actually increasing, in California. In 1988, there were an estimated 950 known occupied NSO pair territories in California. By 1992, that estimate had increased to 2,061, and by 2003 that estimate had increased to 2699 NSO sites. By 2012, this number has increased to 3.061 known NSO pair territories. Up until 2003, the U.S. Fish and Wildlife Service (USFWS) was recognizing sites that had been unoccupied for three consecutive years as being abandoned, and eligible for removal from the database. Since that time, no NSO sites have been recognized as abandoned and continue to be protected pursuant to the California Forest Practice Rules (CFPR).

In addition, the acres of NSO habitat protected pursuant to the CFPR and federal listing protections have increased over this same period; from 2,266,255 acres in 1988 to 5,004,161 acres in 2012. The data contradict the assertions presented in the petition that claim that NSO populations and habitat are declining. (See Exhibit A.)

California forest owners have been surveying for NSO for more than two decades and data from these surveys substantiate these population trends. These numbers are supported by information collected from forest owners in California. These forest owners have been collecting NSO information for years –and in many cases, for decades –and have been surveying using established USFWS survey protocols, often in cooperation with the USFWS. This information is submitted to DFW's database, and is often shared with the USFWS or other agencies. Unlike the information presented by the petitioner in their petition, the population data gathered by these forest landowners are accurate, current, and specifically relevant to the California population of Northern spotted owls. This information shows, once again, that the NSO population on California's private forestlands is stable. Please reference the 584-page *"Northern Spotted Owl Science Compendium,"* submitted to the DFW by the California Forestry Association dated May 1, 2014.

California's robust regulatory process protects both the NSO and its habitat. Timber harvesting in California is regulated pursuant to California's Forest Practice Act and Regulations. The review, approval and enforcement of its discretionary environmental permit, Timber Harvest Plan, (THP) is conducted by a multi-agency team led by CAL FIRE and other trustee agencies, contain specific NSO protection measures. These measures were developed in cooperation with the USFWS and contain provisions for the protection of NSO individuals, nests, related activity centers and the surrounding forest habitat. These provisions are reviewed by the USFWS on a periodic basis. Furthermore, specific guidance documents developed in cooperation with the USFWS give landowners and foresters detailed measures to include in their THPs to conform to strict federal "no take" standards. Again, these guidance documents are reviewed and updated by the USFWS on a regular basis.

Habitat for the NSO is abundant and of high quality on California's private forestlands. The dynamic yet stable population of Northern spotted owls on private forestlands in California is indicative of the high-quality habitat that is present on these lands. California's private forestlands are some of the most productive in the nation, for not only the sustainable production of forests and their products, but also for the production of prey and food sources for the Northern spotted owl. This abundant food source actually results in a smaller home range for many Northern spotted owls, quite often resulting in higher densities of NSO on private forestlands than public.

Conclusion

The survey, monitoring, scientific analysis, reporting and regulatory protections referenced in this letter clearly indicate that California's NSO population is well distributed across its range, is dynamic yet stable over the past quarter century, and is subject to a regulatory system that protects against mortality while providing quality nesting, roosting, and foraging habitat that moves across the landscape over time.

Moreover, California's in-place regulatory system provides the most powerful environmental protections for the NSO of any state in the nation, and as Director Bonham pointed out in his letter of January 16, 2014:

> During the past two decades after NSO became federally listed, sections 919.10 and 939.10 of the California Forest Practice Rules (FPRs) have obligated the California Department of Forestry and Fire Protection (CalFire) to make a finding for each timber harvesting plan (THP) within the range of the NSO that the THP will avoid take of any NSO as defined by the federal Endangered Species Act (ESA). To our knowledge, CalFire in coordination with the U.S. Fish and Wildlife Service and the Department, has effectively implemented this regulatory requirement, allowing THPs to proceed while avoiding take of NSOs. Take as defined by the ESA includes "harm" and "harass," activities which extend well beyond the definition under the Fish and Game Code; viz, "hunt, pursue, catch, capture or kill or attempt to hunt, pursue, catch, capture or kill." The Department concludes a CalFire finding that take under ESA of any NSO would be avoided in accordance with the FPRs would likely be valid for take as defined in the Fish and Game Code.

Given all of the above, it is our strong recommendation that it is unnecessary to duplicate the federal listing, and the NSO should not be recommended by the DFW for listing pursuant to CESA.

Sincerely,

David A. Bischel
California Forestry Association

Valerie Nera
California Chamber of Commerce

Eric Carlson
Associated California Loggers

Noelle Cremers
California Farm Bureau Federation

Justin Oldfield
California Cattlemen's Association

Cyndi Hillery
Rural County Representatives of California

EXHIBIT A – pg1

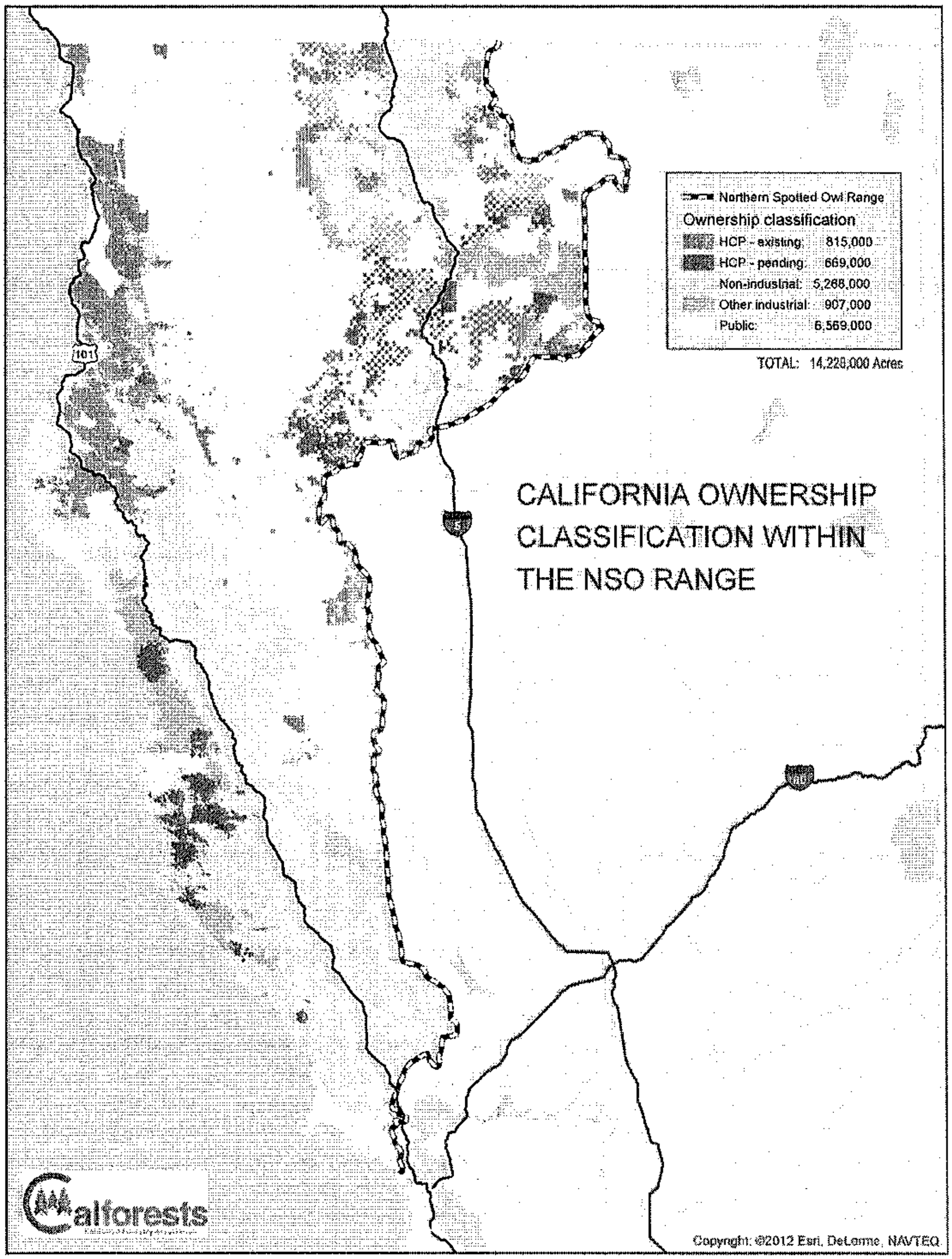


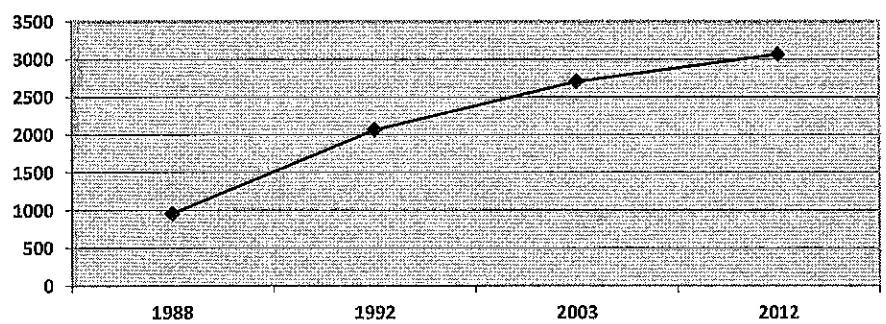
EXHIBIT A - pg2

California's Total Acres within the Northern Spotted Owl Range

Public Forests	6.569 million acres
Private Non-industrial	5.268 million acres
Industrial Forests	2.391 million acres
TOTAL	14.228 million acres

California Dept. of Fish & Wildlife Northern Spotted Owl Data

NSO Territorial Sites



Acres of Habitat within USFWS Designated Owl Circles

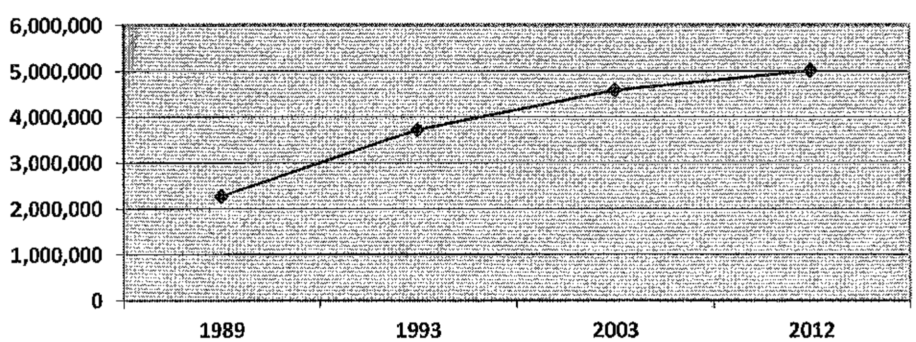


EXHIBIT A – pg3

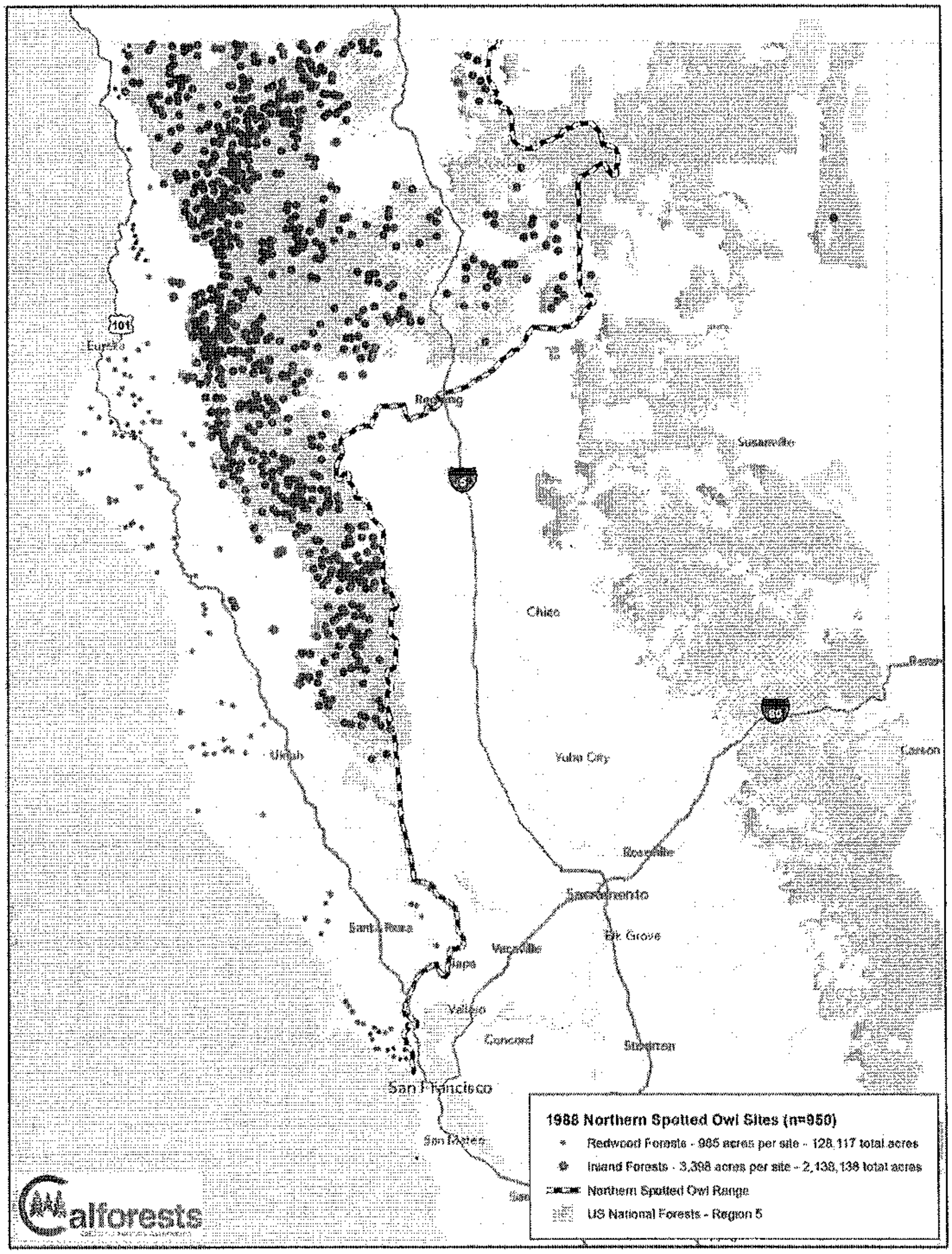
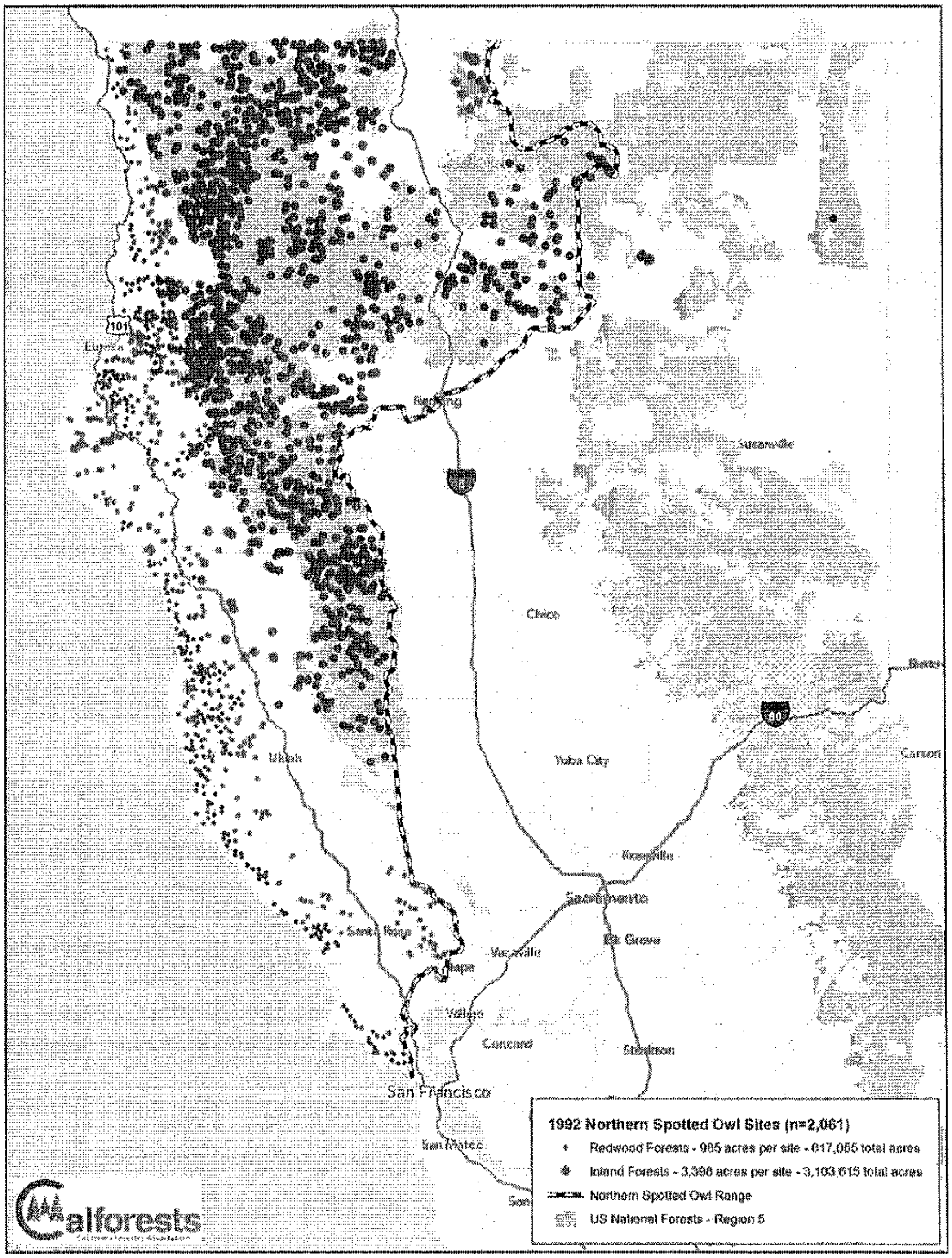


EXHIBIT A – pg4



Neil Clipperton
Calif. Dept. of Fish & Wildlife
May 1, 2014, Page 8

EXHIBIT A – pg5

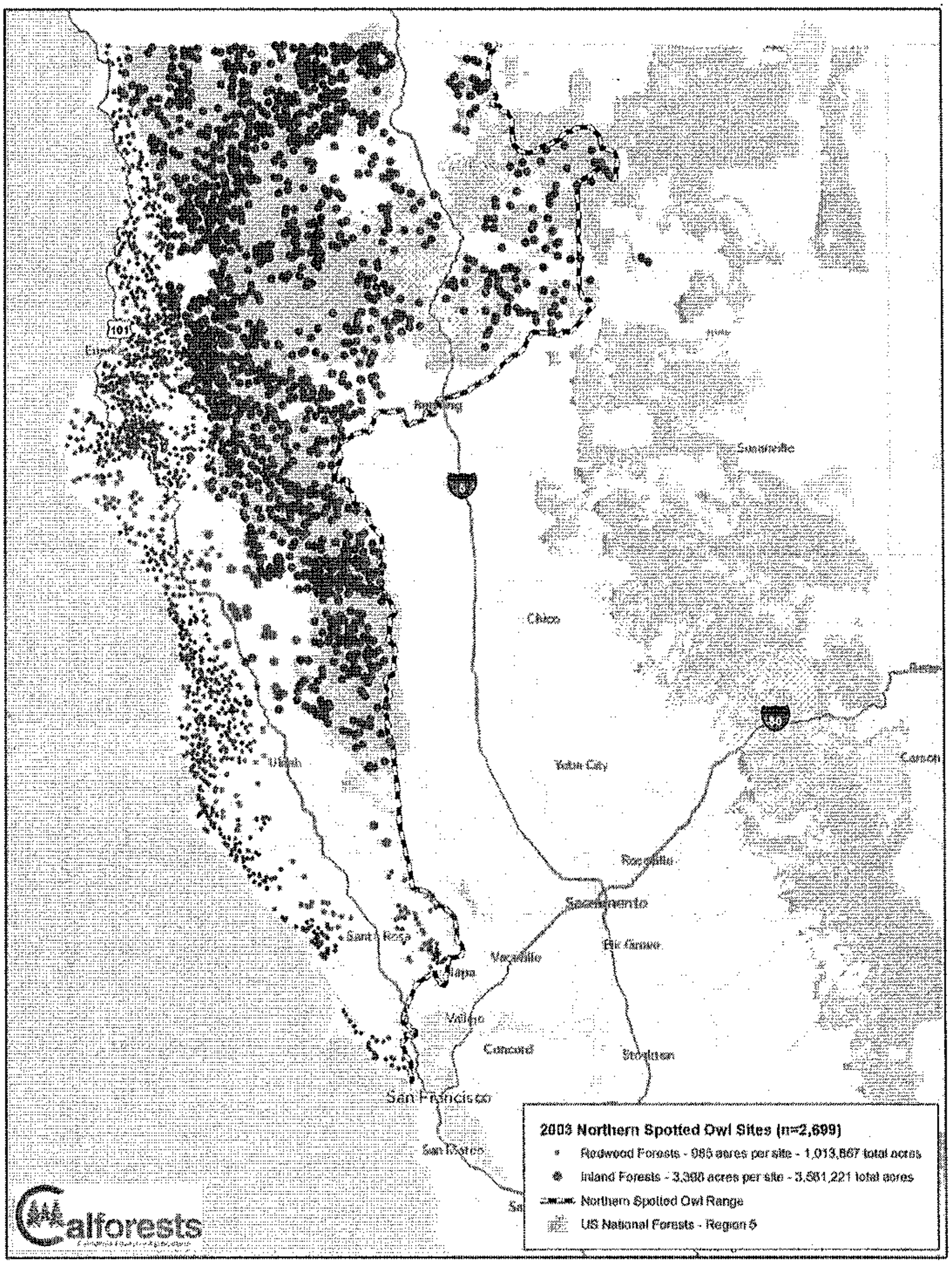
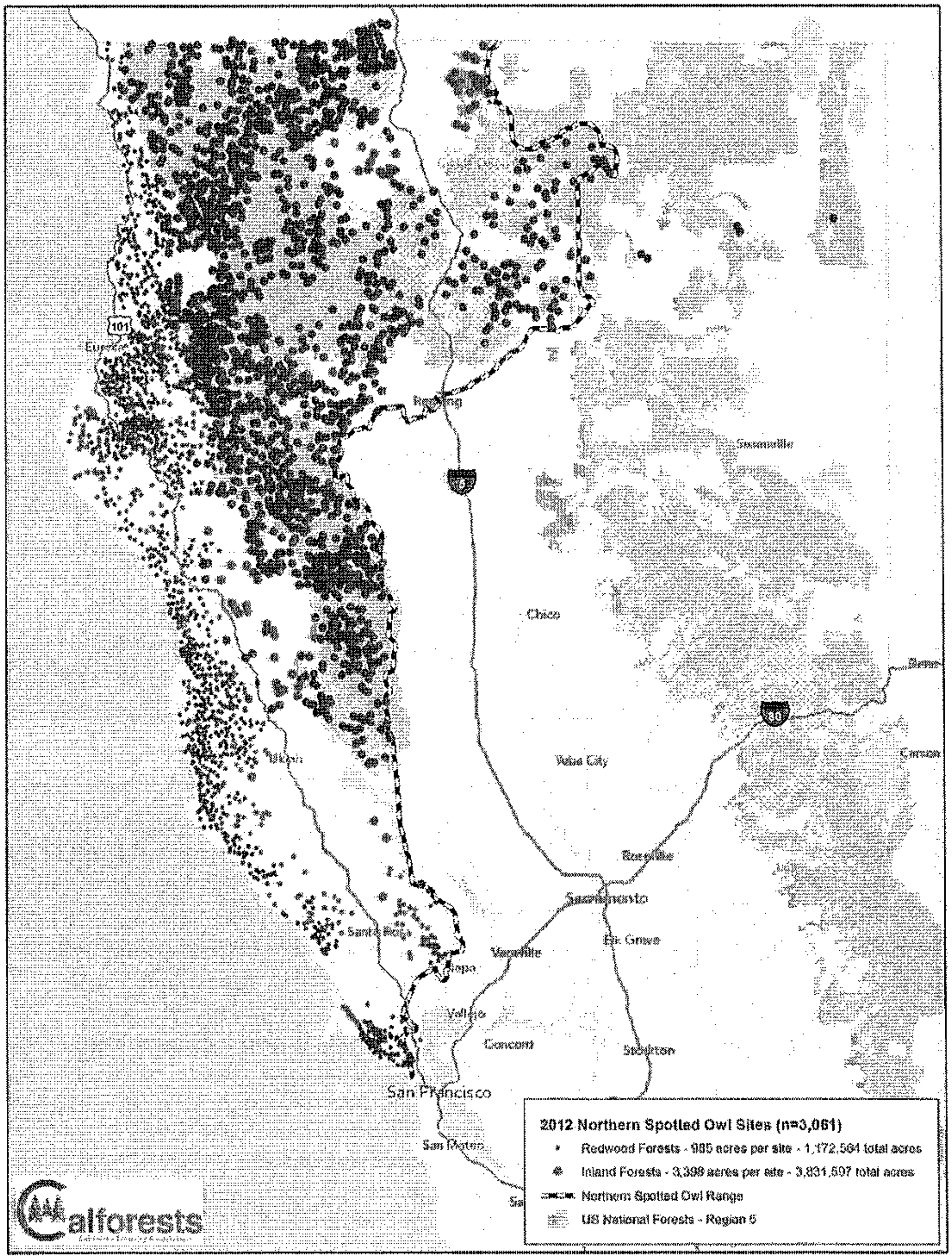


EXHIBIT A – pg6



From:	Sophia Runne <sophiar@calforests.org>
Sent:	Thursday, May 01, 2014 3:47 PM
To:	Wildlife Management
Subject:	Northern Spotted Owl
Attachments:	Orgs Oppose NSO Listing Petition Ltr May 1 2014.pdf
Importance:	High

May 1, 2014

RE: REJECT THE PETITION TO LIST THE NORTHERN SPOTTED OWL (NSO) AS A THREATENED SPECIES UNDER THE CALIFORNIA ENDANGERED SPECIES ACT (CESA)

Dear Neil Clipperton:

Pursuant to the Calif. Dept. of Fish and Wildlife (DFW) mandate to conduct a status review of species listed as a candidate under Section 2074.6 of the Calif. Fish and Game Code, the California Forestry Association along with several other organizations hereby request that the DFW consider the following relevant issues, which we believe support a conclusion that the petition to list the Northern spotted owl (*Strix occidentalis caurina*) as a threatened species under the California Endangered Species Act (CESA) should be rejected.

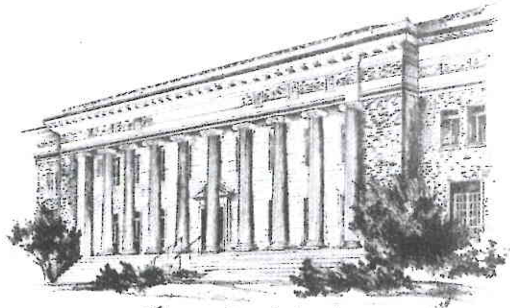
Please see attached letter.

Sophia Runne
Executive Assistant
California Forestry Association
Office: 916-444-6592 / Fax: 916-444-0170
1215 K Street, Suite 1830, Sacramento, CA 95814
www.calforests.org

Board of Supervisors

COUNTY OF TEHAMA

District 1 – Steve Chamblin
District 2 – Sandy Bruce
District 3 – Dennis Garton
District 4 – Bob Williams
District 5 – Burt Bundy



Tehama County Courthouse

Williams J. Goodwin
Chief Administrator

April 15, 2014

California Department of Fish and Wildlife
Public Comments Processing
Attn: Neil Clipperton
1812 9th Street
Sacramento, CA 95811

RE: PROPOSED RULE/DRAFT ENVIRONMENTAL ASSESSMENT/DRAFT ECONIMIC ANALYSIS- REVISED CRITICAL HABITAT FOR THE NORTHERN SPOTTED OWL

Dear California Department of Fish and Wildlife,

The Tehama County Board of Supervisors received notice of the California Department of Fish and Wildlife's intent to list Northern spotted owl as endangered or threatened species and to designate Critical Habitat areas for the special status species.

The Tehama County Board of Supervisors firmly opposes the listing of this species as endangered because of the potential irreparable damage to our and neighboring counties' local economy. Critical habitat designations will restrict land access and can limit or even forbid activities such as grazing, trout stocking, logging, mining, and recreational use resulting in a devastating impact on our economy and other northern rural counties that will be affected.

The Tehama County Board of Supervisors urges that you consider alternative methods for preserving this species and the role that federal and private lands play in the economy of this county and the north state when making your final determination in this matter. The County recommends that all private lands (with or without formal conservation agreements), State lands (Parks and State Forest), county lands and all congressionally reserved natural areas (e.g. wilderness areas, national scenic areas and national parks) be excluded from designated Critical Habitat areas for the special species status.

Thank you for considering our concerns.

Sincerely,

Steve R. Chamblin

Steve Chamblin
Chairman

Cc. Senator Jim Nielsen
2635 Forest Avenue, Ste 110
Chico, CA 95928

Assemblyman Dan Logue
150 Amber Grove Dr., Ste 154
Chico, CA 95973