



Keeping Northwest California wild since 1977

July 2, 2013

California Board of Forestry and Fire Protection
Attn: Eric Huff
Regulations Coordinator
P.O. Box 944246
Sacramento, CA 94244

RE: Northern Spotted Owl Protection Measures Amendments 2013 – Rulemaking to Delete of Title 14 CCR §919.9(g)[939.9(g)]

Dear Responsible Officials,

The Environmental Protection Information Center (EPIC), a nonprofit organization that works to protect and restore ancient forests, watersheds, coastal estuaries, and native species in northern California, respectfully submits the following comments to the California Board of Forestry and Fire Protection (hereinafter “Board”) regarding the above captioned rulemaking proposal.

EPIC asserts that the only the legally viable action for the Board to take on this rulemaking proposal is to immediately delete Title 14 CCR §919.9(g)[939.9(g)] (hereinafter “Option g”) of the Forest Practice Rules as requested in EPIC’s original petition dated February 6, 2013. This is the only action that is supported by the available evidence and in compliance with applicable state and federal law. In addition, deleting Option “g” will relieve the Board and the Department of Forestry and Fire Protection (hereinafter “CAL FIRE”) from liability for illegal “take” of Northern Spotted Owls as prohibited by state and federal law. EPIC hereby incorporates by reference the original petition and all supporting materials into this comment letter on the rulemaking proposal.

The Northern Spotted Owl and illegal taking under the Endangered Species Act

The Northern Spotted Owl, (*Strix occidentalis caurina*), is listed as “threatened” under the Endangered Species Act (“ESA”). Under the ESA, “take” means to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” 16 U.S.C. § 1532(19). The statutory definition of the term “take” is further defined by regulations promulgated by the U.S. Fish and Wildlife Service (“USFWS”) which define the

Environmental Protection Information Center

145 G Street, Suite A, Arcata, CA 95521 | (707) 822-7711

www.wildcalifornia.org

terms “harm” and “harass,” as used in the Act’s definition of “take.” The USFWS regulations define “harm” to mean:

[a]n act that actually kills or injures wildlife. Such acts may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

50 C.F.R. § 17.3. The United States Supreme Court upheld this definition of “harm” specifically for Northern Spotted Owls and establishing the precedent for all ESA-listed species in *Babbitt v. Sweet Home Chapter of Communities for a Greater Oregon*, 527 U.S. 687 (1995). “Harass” is defined to mean “an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns, including breeding, feeding or sheltering.” *Id.*

The destruction of habitat relied upon by ESA-listed species constitutes “take.” *See Marbled Murrelet v. Babbitt*, 83 F.3d 1060, 1069 (9th Cir. 1996) (activity could be enjoined before take occurs and “a habitat modification which significantly impairs the breeding and sheltering of a protected species amounts to ‘harm’ under the ESA”); *Marbled Murrelet v. Pacific Lumber Co.*, 880 F. Supp. 1343, 1367 (N.D. Cal. 1995) (timber harvesting during breeding season could “harass” marbled murrelets by “annoying them to such an extent that it will significantly disrupt their normal behavior patterns”).

Deletion of Option “g” is absolutely essential for the Board and the Department to comply with the federal ESA to avoid “take” and by extension to comply with relevant state law to avoid “take” of Northern Spotted Owl. To be clear, every time a timber harvest plan (“THP”) is approved by CAL FIRE under Option “g” the Board and CAL FIRE are taking on liability for illegal “take” of Northern Spotted Owls. In particular, Option “g” does not meet the USFWS habitat retention requirements for “take” avoidance as set forth in the “take” avoidance guidelines. See attached USFWS 2009. Therefore, CAL FIRE is put in the position of making a determination on whether or not “take” will occur under the ESA whenever the agency approves a THP under Option “g” and can be prosecuted for this violation of the ESA.

The available evidence as detailed by USFWS (2009) conclusively shows that THPs approved by CAL FIRE over the last 10-15 years has resulted in significant habitat loss and most importantly, the loss of active nesting pairs, impairing the ability of the species to persist on private forests in California. This is a critical point that must not be lost by the Board in its deliberations.

Option “g” Threatens Northern Spotted Owls

Option “g” has been demonstrated, through actual implementation and monitoring by owl biologists, to result in “take” of Northern Spotted Owls. Evidence of this is demonstrated from years of analysis and review conducted by the USFWS while providing Technical Assistance on individual THPs as described in USFWS (2009). In this document, the expert agency, USFWS, clearly shows that Northern Spotted Owls and their habitat have not been adequately protected

by implementation of THPs approved under Option “g.”

The USFWS (2009) analysis provides the following statement regarding the effectiveness of Option “g” to prevent “harm” to NSO:

...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.

(USFWS 2009 at 11 (emphasis added). The same document advises that:

...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 [Northern Spotted Owl].

(USFWS 2009 at 12). These are very strong statements from the expert agency on Northern Spotted Owls, and these statements and experience should not be ignored by the Board.

Conflict of Interest

EPIC asserts that one member of the Board of Forestry, Richard Wade, has a conflict of interest that requires recusal from the final vote on this matter. Section 737(a) of the Public Resources Code prohibits any board member with “a direct personal financial interest” from participating in a board action [as described in Articles 8 or 9 of the Forest Practice Act]. In general conflicts of interest are governed by Political Reform Act, § 87100 *et seq.* of the Government Code, and the agency-specific conflicts of interest codes required by § 87300. Under § 87103, a public official has a conflicting “financial interest” when it is “reasonably foreseeable that the decision will have a material financial effect, distinguishable from its effect on the public generally” upon that official or entities closely linked to the official, including “[a]ny business entity in which the public official is a director, officer, partner, trustee, employee, or holds any position of management.” A board member employed at any entity benefiting from Option “g” falls under § 87103.

Because member Richard Wade is a manager for Sierra Pacific Industries, an entity that heavily relies on Option “g”, it is very clear that member Wade has a “financial interest” in the outcome of this rulemaking proposal, and therefore recusal is required for this matter.

Conclusion

In order to comply with state and federal law, there is only one viable action for the Board to take at this time: immediately delete Option “g” from the Forest Practice Rules and

work with the expert agency, USFWS, to ensure compliance with the ESA.

Sincerely,

Andrew J. Orahoske, Conservation Director
Environmental Protection Information Center
145 G Street, Suite A
Arcata, California 95521
Office: (707) 822-7711

Attachments:

EPIC 2013. Petition to delete Option “g” to the California Board of Forestry including all supporting materials. Submitted on February 6, 2013.

USFWS. 2009. Regulatory and Scientific Basis for U.S. Fish and Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in California’s Northern Interior Region.



Keeping Northwest California wild since 1977

February 6, 2013

Mr. Stan Dixon, Chairman
California Board of Forestry and Fire Protection
P.O. Box 944246
Sacramento, CA 94244

Re: PETITION FOR ADMINISTRATIVE RULEMAKING (Gov. Code §§ 11340.6, 11340.7, 11346.1, 11346.4): Delete Title 14 California Code of Regulations § 919.9(g)[939.9(g)]

Dear Responsible Officials,

The Environmental Protection Information Center (“EPIC”) hereby petitions the California Board of Forestry and Fire Protection (“Board”) to amend the California Code of Regulations (“CCR”), Title 14 §919.9 [939.9] to eliminate subsection (g), as provided herein.

EPIC makes this request pursuant to Government Code section 11340.6, which states that “any interested person may petition a state agency requesting the adoption, amendment, or repeal of a regulation” Further, Government Code section 11340.7, subsection (a), provides that:

Upon receipt of a petition requesting the adoption, amendment, or repeal of a regulation pursuant to Article 5 (commencing with Section 11346), a state agency shall notify the petitioner in writing of the receipt and shall within 30 days deny the petition indicating why the agency has reached its decision on the merits of the petition in writing or schedule the matter for public hearing in accordance with the notice and hearing requirements of that article.

EPIC requests that this matter be placed on the Board’s agenda for adoption as promptly as possible, so that the Board may immediately begin a 45-day notice and comment period pursuant to Government Code section 11346.4, for the purpose of adopting the proposed amendments as permanent regulations at the Board’s regular May 2013 meeting.

Purpose

The purpose of this petition is to bring the California Forest Practice Rules (“FPRs”), particularly Title 14 CCR 919.9 [939.9] into compliance with applicable federal guidelines for “take”

Environmental Protection Information Center

145 G Street, Suite A, Arcata, CA 95521

(707) 822-7711

www.wildcalifornia.org

avoidance of Northern Spotted Owl, (*Strix occidentalis caurina*), a species listed as “threatened” under the Endangered Species Act (“ESA”), by deleting the provisions of Title 14 CCR §919.9(g)[939.9(g)]. Under the ESA, “take” means to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” 16 U.S.C. § 1532(19). The statutory definition of the term “take” is further defined by regulations promulgated by the U.S. Fish and Wildlife Service (“USFWS”) which define the terms “harm” and “harass,” as used in the Act’s definition of “take.” The USFWS regulations define “harm” to mean:

[a]n act that actually kills or injures wildlife. Such acts may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

50 C.F.R. § 17.3. The United States Supreme Court upheld this definition of “harm” specifically for Northern Spotted Owls and establishing the precedent for all ESA-listed species in *Babbitt v. Sweet Home Chapter of Communities for a Greater Oregon*, 527 U.S. 687 (1995). “Harass” is defined to mean “an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns, including breeding, feeding or sheltering.” *Id.*

The destruction of habitat relied upon by ESA-listed species constitutes “take.” See *Marbled Murrelet v. Babbitt*, 83 F.3d 1060, 1069 (9th Cir. 1996) (activity could be enjoined before take occurs and “a habitat modification which significantly impairs the breeding and sheltering of a protected species amounts to ‘harm’ under the ESA”); *Marbled Murrelet v. Pacific Lumber Co.*, 880 F. Supp. 1343, 1367 (N.D. Cal. 1995) (timber harvesting during breeding season could “harass” marbled murrelets by “annoying them to such an extent that it will significantly disrupt their normal behavior patterns”).

Deletion of subsection “g” (otherwise referenced as “Option g”) results in eliminating but one of several options under the FPRs for avoiding “take” of Northern Spotted Owls. The California Department of Forestry and Fire Protection (“CAL FIRE”) and proponents of individual Timber Harvest Plans (“THPs”) will still be left with Title 14 CCR 919.9[939.3] options (a)-(f). THP submitters will still have the opportunity to consult with the USFWS via the programmatic Technical Assistance process pursuant to 14 CCR §919.9(e) [939.9(e)].

Existing Regulations Fail to Adequately Protect Northern Spotted Owls

The provisions of Title 14 CCR § 919.9(g) [939.9(g)] have been demonstrated through actual implementation and monitoring to be inadequate to prevent “harm” to Northern Spotted Owls and implementation of “Option g” in the FPRs has resulted in “take” of Northern Spotted Owls. Evidence of this is taken from years of analysis and review conducted by the USFWS while providing Technical Assistance on individual THPs as described in the “*Regulatory and Scientific Basis for U.S. Fish and Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in California’s Northern Interior Region*” (hereinafter “USFWS 2009”). In this document, the expert agency, USFWS, clearly shows that Northern

Spotted Owls and their habitat have not been adequately protected by implementation of the provisions of Title 14 CCR §919.9(g) [939.9(g)]. A copy of this document is incorporated by reference herein and provided in the list of attachments to this petition.

The USFWS Regulatory and Scientific Basis document provides the following statement regarding the effectiveness of Title 14 CCR§ 919.9(g) [939.9(g)] to prevent “harm” to NSO:

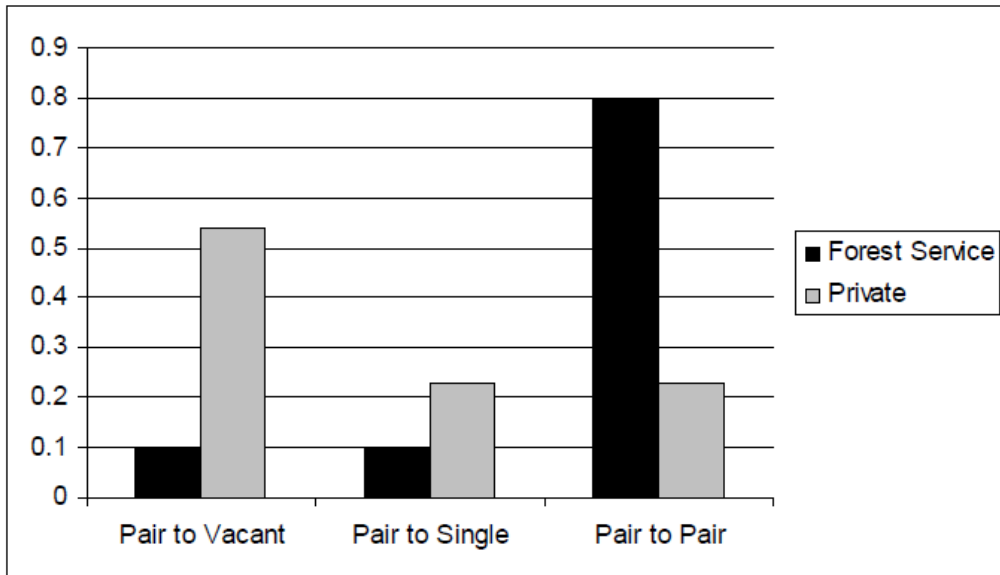
...our combined experience with hundreds of THPs indicates that **the cumulative effects of repeated entries within many NSO home ranges has reduced habitat quality to a degree causing reduced occupancy rates and frequent site abandonment.** In a large proportion of technical assistance letters to CAL 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.

(USFWS 2009 at 11 (emphasis added). The same document advises that:

...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 [Northern Spotted Owl].

(USFWS 2009 at 12). The graph reproduced below developed by the USFWS illustrates the trends of Northern Spotted Owl occupancy on public versus private ownerships in northern California

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



Only a little less than one quarter of Northern Spotted Owl pairs present on private lands in California at the beginning date of the analysis persisted to the end, by contrast to 80% of such pairs that persisted on federal National Forest lands. These striking differences in Northern Spotted Owl occupancy rates on public versus private lands in California are the direct result of habitat modification and removal permitted by the State of California pursuant to the provisions of Title 14 CCR § 919.9(g) [939.9(g)].

The USFWS notes several reasons why the current FPRs are not adequate to evaluate or avoid “take.” These reasons include new information available since the FRPs were enacted (which have changed the amount required, the habitat definitions, and spatial arrangement criteria), the USFWS’ experience with the Technical Assistance process, and analysis indicating loss of territories under the FPRs. The USFWS discussed some of the deficiencies of the current FPRs:

When the FPR guidelines were adopted in 1992, data relating habitat variables to occupancy, reproduction, and survival of [Northern Spotted Owl] were limited. The FPR guidelines for avoiding incidental take of [Northern Spotted Owl] were therefore based on comparison of proposed post-harvest habitat conditions with the amount and of quality of habitat observed at occupied [Northern Spotted Owl] sites described in various studies. Under this standard, habitat modification potentially could result in substantial reduction of reproduction, survival, and occupancy at [Northern Spotted Owl] activity centers without the appearance of take, because habitat conditions resemble other low-quality [Northern Spotted Owl] territories. [Northern Spotted Owls] are known to occupy low-quality sites where their reproduction and survival are substantially reduced (Franklin et al. 2000, Dugger et al. 2005); the existence of these low quality sites suggests that reliance on habitat conditions corresponding to the presence or of owls at historic territories represents a low bar for determining habitat thresholds and take.

(USFWS 2009 at 5). In response to these findings, the USFWS issued its own set of Northern Spotted Owl “take” avoidance guidelines as part of its issuance of the Regulatory and Scientific Basis document, stating that these new guidelines were more effective in avoiding “take.”

One significant difference between the FPRs and the USFWS “take” avoidance guidelines is the use of different definitions for each type of habitat. The USFWS Guidelines contain habitat definitions that are far more detailed and specific than the habitat definitions provided in 14 CCR § 895.1. The magnitude of the difference between the two is demonstrated by the fact that what qualifies as roosting habitat under the FPRs would at best qualify for low-quality foraging habitat under the USFWS’ definitions.

The USFWS further expounds on the inadequacies of the FPR definitions and the implications for NSO:

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.

(E-mail from Brian Woodbridge, USFWS to Chris Browder, CALFIRE. April 22, 2009).

Another significant difference between the USFWS' guidance and the provisions of Title 14 CCR § 919.9(g) [939.9(g)] is the amount and specific configuration of habitat required for retention within an Northern Spotted Owl home range (1.3 mile radius) required to avoid "take." Currently, the provisions of Title 14 CCR § 919.9(g) [939.9(g)] do not require that specific amounts of individual habitat types be retained. Rather, "Option g" currently relies on an aggregate habitat retention strategy that allows for reduction of habitat quality and quantity to uniformly low values, increasing the likelihood of "harm" or "take." To put it simply, "Option g" treats all owl habitats as equal, and fails to provide sufficient nesting and roosting habitat, which is the primary limiting factor for the species.

Finally, there are currently no provisions to prevent the damaging effects of repeated and successive entries into individual Northern Spotted Owl home ranges, resulting in "take" via cumulative impacts. The USFWS' programmatic guidance addresses this issue by establishing core areas of use (generally 0.5 miles in the interior, 0.7 miles on the coast) in which timber harvest activities are restricted, and specific amounts of high-quality habitat are to be retained.

Practical Effect of Proposed Rulemaking

To date, CAL FIRE has been encouraging project proponents to implement the provisions of the USFWS' programmatic guidance pursuant to Title 14 CCR § 919.9(e)[939.9(e)] but cannot require use of the USFWS guidance because they are not codified in regulation. Nonetheless, most landowners and THP submitters have voluntarily moved away from application of Title 14 CCR § 919.9(g) [939.9(g)]. Thus, the deletion of "Option g" would simply nullify an antiquated set of Rules that have been shown to be inadequate and that very few operations are using.

The benefits of adopting the proposed rulemaking petition are clear. First, deletion of Title 14 CCR § 919.9(g) [939.9(g)] would reconcile remaining FPRs with the guidance of the USFWS with respect to Northern Spotted Owl "take" avoidance. Furthermore, adoption of this petition to remove "Option G" would relieve CAL FIRE of any discretionary duties of making so-called "take avoidance determinations" on a project by project basis. It is and has been EPIC's position that CAL FIRE does not have the legal authority to make such determinations. Deletion of Title 14 CCR § 919.9(g)[939.9(g)] would relieve CAL FIRE of these duties and reduce liability for prosecution of illegal "take" for both the Department and the Board of Forestry. Finally, the deletion of Title 14 CCR § 919.9(g) [939.9(g)] would benefit Northern Spotted Owl and the environment as a whole by raising the standards for protection, thus leading to older, healthier forests.

Evidence in Support of This Rulemaking Petition

In support of this petition, EPIC provides an extensive volume of peer-reviewed and published studies regarding Northern Spotted Owls and the threats posed by irresponsible habitat destruction. EPIC incorporates by reference all the following documentation contained on an

electronic media device submitted with the petition and detailed in the “Supporting Evidence” section at this end of this document.

Conclusion

The proposed rulemaking in this petition is a feasible measure that can be taken by the Board at this time to address a glaring deficiency and inconsistency in the FPRs. Complying with federal standards to protect Northern Spotted Owls is desperately needed as the species is continuing a downward spiral towards extinction. EPIC believes that only a small number of landowners and THP submitters will be affected by the deletion of “Option g” as requested. In contrast, failure to act on this petition could have substantial consequences for Northern Spotted Owls on private lands in California. Furthermore, failure to act leaves both CAL FIRE and the Board of Forestry at risk of legal challenges, and would fail to serve the Board’s responsibilities to protect, enhance, and restore native wildlife.

Authority

The Board has authority to adopt the following regulatory amendments pursuant to Public Resources Code sections 4551, 4551.5, 4553, 4562.7. . The proposed amendments are directly necessary to effectuate the goals of the Z’Berg-Nejedly Forest Practices Act of 1973, including, but not limited to its goals to “to protect the soil, air, fish, and wildlife, and water resources, including, but not limited to, streams, lakes, and estuaries” (§ 4551), and of “[p]roviding watershed protection and maintaining fisheries and wildlife” (§ 4512, subd. (b)). The Board may adopt these amendments promptly, as there is substantial evidence documenting the need to eliminate “Option g.” There is an urgent need to provide necessary protection for Northern Spotted owls impacted by private timber operations that utilize “Option g” as permitted by the State of California in defiance of clear conflicts with federal law.

Sincerely,

Rob DiPerna
Industrial Forestry Reform Advocate

Environmental Protection Information Center
145 G Street, Suite A
Arcata, California 95521
Office: (707) 822-7711
Email: rob@wildcalifornia.org

Amendments

EPIC request that the Board amend California Code of Regulations, Title 14, § 919.9[939.9] in the following manner:

919.9, 939.9 Northern Spotted Owl [Coast, Northern]

Every proposed timber harvesting plan, NTMP, conversion permit, Spotted Owl Resource Plan, or major amendment located in the Northern Spotted Owl Evaluation Area or within 1.3 miles of a known northern spotted owl activity center outside of the Northern Spotted Owl Evaluation Area shall follow one of the procedures required in subsections (a)-(g)(f) below for the area within the THP boundary as shown on the THP map and also for adjacent areas as specified within this section. The submitter may choose any alternative (a)-(g)(f) that meets the on-the-ground circumstances. The required information shall be used by the Director to evaluate whether or not the proposed activity would result in the "take" of an individual northern spotted owl.

When subparagraphs (a), (b), (c) or (f) are used, the Director, prior to approval of a THP, shall consult with an SOE and conduct an independent review. ~~An SOE may aid the RPF in fulfilling the requirements within subdivision (g).~~ The SOE may make written recommendations regarding whether the retained habitat configuration and protection measures proposed in the THP will prevent a take of the owl.

~~(g) Where an activity center has been located within the plan boundary or within 1.3 miles of that boundary, the RPF shall determine and document in the plan: (i) activity center specific protection measures to be applied during timber operations and (ii) owl habitat, including habitat described in (1)-(5) below, that will be retained after the proposed operations are completed:~~

~~(1) Within 500 feet of the activity center the characteristics of functional nesting habitat must be maintained. No timber operations shall be conducted in this area during the northern spotted owl breeding season unless reviewed and approved by the Director as not constituting a take. Timber operations may be conducted in this area outside the breeding season if appropriate measures are adopted to protect nesting habitat.~~

~~(2) Within 500-1000 feet of the activity center, retain sufficient functional characteristics to support roosting and provide protection from predation and storms. No timber operations shall be conducted in this area during the breeding season unless reviewed and approved by the Director as not constituting a take.~~

~~(3) 500 acres of owl habitat must be provided within a .7 mile radius of the activity center, unless an alternative is reviewed and approved by the Director as not constituting a take. The 500 acres includes the habitat retained in subsections (1) and (2) above and should be as contiguous as possible. Less than 50% of the retained habitat should be under operation in any one year, unless reviewed and approved by the Director as not constituting a take.~~

~~(4) 1336 total acres of owl habitat must be provided within 1.3 miles of each activity center, unless an alternative is reviewed and approved by the Director as not constituting a take. The 1336 acres includes the habitat retained within subsections (1)-(3) above.~~

~~(5) The shape of the areas established pursuant to subsections (1) and (2) shall be adjusted to conform to natural landscape attributes such as draws and streamcourses while retaining the total area required within subsections (1) and (2) above.~~

Supporting Evidence

All documents listed below are incorporated by reference into EPIC's petition for rulemaking to the California Board of Forestry requesting deletion of Title 14 California Code of Regulations § 919.9(g)[939.9(g)].

- Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, G.C. White, C.J. Schwarz, J. Nichols, J.E. Hines, G.S. Olson, S.H. Ackers, S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, K.M. Dugger, K.E. Fehring, T.L. Fleming, R.P. Gerhardt, S.A. Gremel, R.J. Gutiérrez, P.J. Happe, D.R. Herter, J.M. Higley, R.B. Horn, L.L. Irwin, P.J. Loschl, J.A. Reid, and S.G. Sovern. 2006. Status and trends in demography of northern spotted owls, 1985–2003. Wildlife Monograph No. 163.
- Bailey, L.L., J.A. Reid, E.D. Forsman and J.D. Nichols. 2009. Modeling co-occurrence of northern spotted and barred owls: Accounting for detection probability differences. *Biological Conservation* 142: 2983-2989.
- Barrowclough, G.F. and R.J. Gutierrez. 1990. Genetic variation and differentiation in the spotted owl (*Strix occidentalis*). *The Auk* 107: 737-744.
- Barrowclough, G.F., R.J. Gutiérrez, and J.G. Groth. 1999. Phylogeography of spotted owl (*Strix occidentalis*) populations based on mitochondrial DNA sequences; gene flow, genetic structure, and a novel biogeographic pattern. *Evolution* 53:919–931.
- Barrowclough, G.F., J.G. Groth, and R.J. Gutiérrez RJ. 2005. Genetic structure, introgression and a narrow hybrid zone between northern and California spotted owls (*Strix occidentalis*). *Molecular Ecology* 14:1109–1120.
- Bart, J, and E.D. Forsman. 1992. Dependence of Northern Spotted Owls, *Strix occidentalis caurina*, on Old-Growth Forests in the Western United States. *Biological Conservation* 62:95-100.
- Berg, K., S.Cantrell, M. Doumit, K. Godbout, D. Halabisky, C. Lipton, R. Meier, V. Musselman, M. Perez-Gibson, T. Robinson, P. Swedeen, C. Turley, and D. Whipple. 2009. Final Report to Forest Practices Board, Northern Spotted Owl Policy Working Group. Including: November 10, 2009 Report and December 31, 2009 Report.
- Blakesley, J.A., W. LaHaye, J.M.M. Marzluff, B.R. Noon, and S. Courtney. 2004. Demography. Chapter 8 in S. Courtney (editor), *Scientific evaluation of the status of the northern spotted owl*. Sustainable Ecosystems Institute, Portland, Oregon.
- Blakesley, J.A., B.R. Noon, and D.R. Anderson. 2005. Site occupancy, apparent survival, and reproduction of California spotted owls in relation to forest stand characteristics. *Journal of Wildlife Management*. 69:1554-1564.

- Bond, M.L., R.J. Gutierrez, A.B. Franklin, W.S. LaHaye, C.A. May and M.E. Seamans. 2002. Short-term effects of wildfires on spotted owl survival, site fidelity, mate fidelity and reproductive success. *Wildlife Society Bulletin* 30 (4): 1022-1028.
- Bond, M.L., D.E. Lee, R.B. Siegel, and J.P. Ward. 2009. Habitat use and selection by California Spotted Owls in a postfire landscape. *Journal of Wildlife Management* 73: 1116-1124.
- Bosakowski and Smith 1992. Comparative diets of sympatric nesting raptors in the eastern deciduous forest biome. *Can. J. Zool.* 70:984–992.
- Boyce, M.S., L.L. Irwin, and R. Barker. 2005. Demographic meta-analysis: synthesizing vital rates for spotted owls. *Journal of Applied Ecology* 42:38.
- Buchanan, J., and P. Swedeen. 2005. Final Briefing Report to the Washington State Forest Practices Board regarding Spotted Owl Status and Forest Practice Rules. Washington Department of Fish and Wildlife. Olympia, Washington.
- Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1995. Within-stand nest site selection by spotted owls in the eastern Washington Cascades. *Journal of Wildlife Management* 59:301–310.
- Buchanan, J.B., T.L. Fleming, and L.L. Irwin. 2004. A comparison of Barred and Spotted Owl nest-site characteristics in the eastern Cascade Mountains, Washington. *J. Raptor Res.* 38:231–237.
- Buchanan, J.B., R.J. Gutierrez, R.G. Anthony, T. Cullinan, L.V. Diller, E.D. Forsman, and A.B. Franklin. 2007. A synopsis of suggested approaches to address potential competitive interactions between barred owls and spotted owls. *Biol. Invasions* 9:679-691
- Caffrey C. 2003. Determining impacts of West Nile Virus on crows and other birds. *American Birds* 57:12–13.
- California Forest Practice Rules. 2012. Available at:
http://www.fire.ca.gov/resource_mgt/downloads/2012_California_Forest_Practice_Rules.pdf
- Campbell, S., K. Waddell, and A. Gray, tech. eds. 2010. Washington’s forest resources, 2002–2006: five-year Forest Inventory and Analysis report. Gen. Tech. Rep. PNW-GTR-800. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 189 p. http://www.fs.fed.us/pnw/pubs/pnw_gtr800.pdf
- Campbell, R.W. 1973. Coastal records of the barred owl for British Columbia. *The Murrelet* 54:25.
- Carey, A.B. 1999. Red Tree Vole: *Arborimus longicaudus*. Pages 620-622 in D.E. Wilson and S. Ruff, eds. The Smithsonian Institute Press, Washington, D. C.

- Carey, A.B. 2000. Ecology of northern living squirrels: implications for ecosystem management in the Pacific Northwest, USA. in R. Goldingay and J. Scheibe (eds.) *Biology of Gliding Mammals*. Filander Press: Fürth, Germany.
- Carey, A.B, S.P. Horton, and B.L. Biswell. 1992. Northern spotted owls: influence of prey base and landscape character. *Ecol. Monographs* 62:223–250.
- Carey, A.B., B.R. Lippke, and J. Sessions. 1999. Intentional ecosystem management: managing forests for biodiversity. *Journal of Sustainable Forestry* 9:83–125.
- Carey, A.B. and K.C. Peeler. 1995. Spotted owls: resource and space use in mosaic landscapes. *Journal of Raptor Research* 29:223-239.
- Carrete, M.J., J.A. Sanchez-Zapata, J.F. Calvo, and R. Lande. 2005. Demography and habitat availability in territorial occupancy of two competing species. *Oikos* 108:125-136.
- Carroll, C. and D.S. Johnson. 2008. The importance of being spatial (and reserved): assessing northern spotted owl habitat relationships with hierarchical Bayesian models. *Conservation Biology* 22: 2:1026-1036.
- Chutter, M., I. Blackburn, D. Bonin, J. Buchanan, B. Costanza, D. Cunnington, A. Harestad, T. Hayes, D. Heppner, L. Kiss, J. Surgenor, W. Wall, L. Waterhouse, & L. Williams. 2004. National recovery strategy for the Northern Spotted Owl. Report. Recovery of Nationally Endangered Wildlife Committee, Ottawa, ON.
- Clark, D.A. 2007. Demography and habitat selection of northern spotted owls in post-fire landscapes of southwestern Oregon. M.S. thesis. Oregon State University, Corvallis.
- COSEWIC. 2008. COSEWIC assessment and update status report on the Spotted Owl *Strix occidentalis caurina*, *Caurina* subspecies, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 48 pp.
www.sararegistry.gc.ca/status/status_e.cfm
- Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, and L. Sztukowski. 2004. Final Report: Scientific evaluation of the status of the Northern Spotted Owl. Sustainable Ecosystems Institute, Portland, Oregon.
- Courtney, S.P., A.B. Carey, M.L. Cody, K. Engel, K.E. Fehring, J.F. Franklin, M.R. Fuller, R.J. Gutiérrez, J.F. Lehmkuhl, M.A. Hemstrom, P.F. Hessburg, S.L. Stephens, L.A. Sztukowski, and L. Young. 2008. Scientific Review of the Draft Northern Spotted Owl Recovery Plan and Reviewer Comments. Sustainable Ecosystems Institute, Portland, Oregon.
- Crozier, M.L., M.E. Seamans, R.J. Gutiérrez, P.J. Loschl, R.B. Horn, S.G. Sovern, and E.D. Forsman. 2006. Does the presence of barred owls suppress the calling behavior of Spotted Owls? *Condor* 108:760–769.

- Dark, S.J., R.J. Gutiérrez, and G.I. Gould Jr. 1998. The barred owl (*Strix varia*) invasion in California. *Auk* 115(1):50-56.
- Davis, R. and J. Lint. 2005. Habitat status and trends. Pages 21–82 in J. Lint (technical coordinator), Northwest Forest Plan—the first 10 years (1994–2003): status and trends of northern spotted owl populations and habitat. Gen. Tech. Rep. PNW-GTR-648, USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon.
http://www.fs.fed.us/pnw/publications/pnw_gtr648
- Davis, Raymond J.; Dugger, Katie M.; Mohoric, Shawne; Evers, Louisa; Aney, William C. 2011. Northwest Forest Plan—the first 15 years (1994–2008): status and trends of northern spotted owl populations and habitats. Gen. Tech. Rep. PNWGTR- 850. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 147 p.
- Dellasala, D. 2011. Comments on the 5-year status review for Northern Spotted Owl submitted to the U.S. Fish and Wildlife Service.
- Diller, L.V. and D.M. Thome. 1999. Population density of northern spotted owls in managed young-growth forests in coastal northern California. *Journal of Raptor Research* 33:275–286.
- Doak, D.F. 1994. Declaration of Daniel Doak in Support of SAS’ Motion for Summary Judgment. Declaration in the United States District Court for the Western District of Washington. October 3, 1994. 22 pp.
- Dugger, K.M., F. Wagner, R.G. Anthony, and G.S. Olson. 2005. The relationship between habitat characteristics and demographic performance of northern spotted owls in southern Oregon. *Condor* 107:863–878.
- Dugger, K., R.G. Anthony and E.D. Forsman. 2009. Estimating northern spotted owl detection probabilities: updating the USFWS Northern Spotted Owl Survey Protocol. Final Report. Dept. of Fisheries and Wildlife, Oregon State University, Corvallis.
- Dugger, K., R.G. Anthony, L. S. Andrews. 2011. Transient dynamics of invasive competition barred owls, spotted owls, habitat, and demons of competition present. *Ecol. Applications*.
- Dunbar, D.L., B.P. Booth, E.D. Forsman, A.E. Hetherington, and D.J. Wilson. 1991. Status of the spotted owl, *Strix occidentalis*, and barred owl, *Strix varia*, in southwestern British Columbia. *Canadian Field-Naturalist* 105:464–468.
- Environmental Protection Information Center (EPIC). 2012a. Notice of Intent to Sue Sierra Pacific Industries for Violations of the Endangered Species Act; Actions Threatening the Northern Spotted Owl.
- EPIC. 2012b. Petition to the California Fish and Game Commission to List the Northern Spotted Owl as “Endangered” under the California Endangered Species Act.
- Elderkin, M.F. 1987. The breeding and feeding ecology of a Barred Owl population in Kings County, Nova Scotia. M.S. thesis, Acadia University, Wolfville, Nova Scotia, Canada.

- FEMAT (Forest Ecosystem Management Assessment Team). 1993. Forest Ecosystem Management: an ecological, economic, and social assessment. USDA Forest Service, USDI Fish and Wildlife Service, National Marine Fisheries Service, USDI National Park Service, USDI Bureau of Land Management, Environmental Protection Agency, Washington, D.C.
- Fitzgerald, S.D., J.S. Patterson, M. Kiupel, H.A. Simmons, S.D. Grimes, C.F. Sarver, R.M. Fulton, B.A. Fulton, B.A. Steficek, T.M. Cooley, J.P. Massey, and J.G. Sikarskie. 2003. Clinical and pathological features of West Nile Virus infection in native North American owls (family *Strigidae*). *Avian Diseases* 47:602–610.
- Forest Practice Notes. 1994. Oregon Department of Forestry, No. 8 (Revised), Dec. 1994. Available at: <http://www.oregon.gov/ODF/privateforests/docs/SpottedOwl.pdf>
- Forsman, E.D. 1976. A preliminary investigation of the Spotted Owl in Oregon. M.S. thesis, Oregon State University, Corvallis, OR.
- Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. *Wildlife Monographs* 87:1–64.
- Forsman, E.D., S. DeStefano, M.G. Raphael, and R.J. Gutierrez (eds). 1996. Demography of the northern spotted owl. *Studies in Avian Biology* 17:1-122.
- Forsman, E.D., I.A. Otto, S.G. Sovern, M. Taylor, D.W. Hays, H. Allen, S.L. Roberts, and D.E. Seaman. 2001. Spatial and temporal variation in diets of Spotted Owls in Washington. *J. Raptor Res.* 35:141–150.
- Forsman, E.D., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Sovern, M. Taylor B.L. Biswell, A. Ellingson, E.C. Meslow, G.S. Miller, K.A. Swindle, J.A. Thrailkill, F.F. Wagner, and D.E. Seaman. 2002. Natal and breeding dispersal of northern spotted owls. *Wildlife Monographs*
- Forsman, E.D., R.G. Anthony, K.M. Dugger, E.M. Glenn, A.B. Franklin, G.C. White, C.J. Schwarz, K.P. Burnham, D.R. Anderson, J.D. Nichols, J.E. Hines, J.B. Lint, R.J. Davis, S.H. Ackers, L.S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, S.A. Gremel, D.R. Herter, J.M. Higley, R.B. Horn, J.A. Reid, J. Rockweit, J. Schaberel, T.J. Snetsinger, and S.G. Sovern. 2011. Population Demography of the northern spotted owls: 1985-2008. *Studies in Avian Biology*. In Press.
- Franklin, A.B., K.P. Burnham, G.C. White, R.G. Anthony, E.D. Forsman, C. Schwarz, J.E. Nichols, and J. Hines. 1999. Range-wide status and trends in northern spotted owl populations. Colorado Cooperative Fish and Wildlife Research Unit, USGS, Biological Resources Division, Colorado State University, Ft. Collins, CO, and Oregon Cooperative Fish and Wildlife Research Unit, USGS, Biological Resources Division, Department of Fish and Wildlife, Oregon State University, Corvallis, OR.

- Franklin, A.B., D.R. Anderson, J.R. Gutiérrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. *Ecological Monographs* 70:539–590.
- Franklin J. and S. Courtney. 2004. Evolution and effectiveness of strategies for conservation of northern spotted owl. Chapter 9 in S. Courtney (editor), *Scientific evaluation of the status of the northern spotted owl*. Sustainable Ecosystems Institute, Portland, Oregon.
- Funk, W.C., E.D. Forsman, T.D. Mullins, and S.M. Haig. 2008. Introgression and dispersal among spotted owl (*Strix occidentalis*) subspecies. *Evolutionary Applications* 1:161-171.
- Funk, W.C., E.D. Forsman, M. Johnson, T.D. Mullins, and S.M. Haig. 2010. Evidence for recent population bottlenecks in northern spotted owls (*Strix occidentalis caurina*). *Conservation Genetics* 11:1013-1021.
- Glenn, E.M. 2009. Local Weather, Regional Climate, and Population Dynamics of Northern Spotted Owls in Washington and Oregon. PhD Dissertation Oregon State University.
- Glenn, E.M., M.C. Hansen, and R.G. Anthony. 2004. Spotted owl home-range and habitat use in young forests of western Oregon. *Journal of Wildlife Management* 68:33–50.
- Glenn, E.M., R.G. Anthony, and E.D. Forsman. 2010. Population trends in northern spotted owls: Associations with climate in the Pacific Northwest. *Biological Conservation* *in press*.
- Gutiérrez, R.J., M. Cody, S. Courtney, and D. Kennedy. 2004. Assessment of the potential threat of the northern barred owl. Pp. 7-1 – 7-51, In: S. Courtney, Ed. *Scientific evaluation of the status of the northern spotted owl*. Portland, OR. Sustainable Ecosystems Institute.
- Gutiérrez, R.J. and G.E. Barrowclough. 2005. Redefining the distributional boundaries of the Northern and California Spotted Owls: Implications for Conservation. *The Condor* 107:182-187.
- Gutiérrez, R.J., M. Cody, S. Courtney and A.B. Franklin. 2007. The invasion of barred owls and its potential effect on the spotted owl: a conservation conundrum. *Biological Invasions* 9:181–196.
- Haig, S.M., T.D. Mullins, and E.D. Forsman. 2004. Subspecific relationships and genetic structure in the spotted owl. *Conservation Genetics* 5:683–705.
- Hakkarainen, H., V. Koivunen, and E. Korpimäki. 1997. Reproductive success and parental effort of Tengmalm's Owls: effects of spatial and temporal variation in habitat quality. *Ecoscience* 4:35–42.
- Hamer, T.E. 1988. Home range size of the Northern Barred Owl and Northern Spotted Owl in western Washington. M.S. thesis, Western Washington University, Bellingham, WA U.S.A.
- Hamer, T.E., E.D. Forsman, A.D. Fuchs, and M.L. Walters. 1994. Hybridization between barred and spotted owls. *Auk* 111:487–492.

- Hamer, T. E., E. D. Forsman, and E. M. Glenn. 2007. Home range attributes and habitat selection of barred owls and spotted owls in an area of sympatry. *Condor* 109:750–768.
- Hanson, C.T., D.C. Odion, D.A. DellaSala, and W.L. Baker. 2009. Overestimation of fire risk in the northern spotted owl recovery plan. *Conservation Biology* 23: 1314-1319.
- Hanson, C.T., D.C. Odion, D.A. DellaSala, and W.L. Baker. 2010. Comprehensive management of northern spotted owls in dry forest provinces: response to Spies et al. *Conservation Biology* 24: 334-337.
- Harrison, S., A. Stahl, and D. Doak. 1993. Spatial models and spotted owls: exploring some biological issues behind recent events. *Conservation biology* 7:950-953.
- Hershey, K.T., E.C. Meslow, and F.L. Ramsey. 1998. Characteristics of forests at spotted owl nest sites in the Pacific Northwest. *Journal Wildlife Management* 62:1398-1410.
- Horn, H.S. and R.H. MacArthur. 1972. Competition among fugitive species in a harlequin environment. *Ecology* 53:749-752.
- Irwin, L.L., T.L. Fleming, and J. Beebe. 2004. Are spotted owl populations sustainable in fire-prone forests? *Journal of Sustainable Forestry* 18:1-28.
- Ishak, H.D., J.P. Dumbacher, N.L. Anderson, J.J. Keane, G. Valkiūnas, S.M. Haig, L.A. Tell, and R.N.M. Sehgal. 2008. Blood Parasites in Owls with Conservation Implications for the Spotted Owl (*Strix occidentalis*). *PLoS ONE* 3(5): e2304. doi:10.1371/journal.pone.0002304
- Johnson, K.N. and J.F. Franklin. 2009. Restoration of federal forests in the Pacific northwest: strategies and management implications. Oregon State University, Corvallis.
- Kelly, E.G. 2001. The range expansion of the northern barred owl: an evaluation of the impact on spotted owls. M.S. thesis, Oregon State University, Corvallis, OR.
- Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are barred owls displacing spotted owls? *Condor* 105:45–53.
- Korpimäki, E. 1992. Fluctuation food abundance determines the lifetime reproductive success of male Tengmalm's owls. *Journal of Applied Ecology* 61:103-111.
- LaHaye, W.S. and R.J. Gutiérrez. 1999. Nest sites and nesting habitat of the northern spotted owl in northwestern California. *Condor* 101:324-330.
- Lehmkuhl, J.F., K.D. Kistler, J.S. Begley, and J. Boulanger. 2006. Demography of northern flying squirrels informs ecosystem management of western interior forests. *Ecological Applications* 16:584-600
- Leskiw, T. and R.J. Gutiérrez. 1998. Possible predation of a spotted owl by a barred owl. *Western Birds* 29:225–226.

- Levins, R. and D. Culver. 1971. Regional coexistence of species and competition between rare species. *Proceedings of the National Academy of Science* 68:1246-1248.
- Lint, J. 2005. Population status and trends. Pages 7–19 in J. Lint (technical coordinator), Northwest Forest Plan—the first 10 years (1994–2003): status and trends of northern spotted owl populations and habitat. Gen. Tech. Rep. PNW-GTR-648, USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon.
- Livezey, K.B., M.F. Elderkin, P.A. Cott, J. Hobbs, and J.P. Hudson. 2008. Barred owls eating worms and slugs: the advantage in not being picky eaters. *Northwestern Naturalist* 89: 185-190.
- Livezey, K.B. 2009a. Range Expansion of Barred Owls, Part I: Chronology and Distribution. *Am. Midl. Nat.* 161:49–56
- Livezey, K.B. 2009b. Range Expansion of Barred Owls, Part II: Facilitating ecological changes. *Am. Midl. Nat.* 161:323–349.
- Manning, T., J.C. Hagar and B.C. McComb. 2011. Thinning of young Douglas-fir forests decreases density of northern flying squirrels in the Oregon Cascades. *Forest Ecology and Management* 264: 115-124
- Marra, P.P., S. Griffing, C. Caffrey, A.M. Kilpatrick, R. McLean, C. Brand, E. Saito, A.P. Dupuis, L. Kramer, and R. Novak. 2004. West Nile Virus and wildlife. *BioScience* 54:393–402.
- Mazur, K.M., P.C. James, and S.D. Frith. 1997. Barred Owl (*Strix varia*) nest site characteristics in the boreal forest of Saskatchewan, Canada. Pages 267–273 in J.R. Duncan, D.H. Johnson, and T.H. Nicholls [EDS.], *Biology and conservation of owls of the northern hemisphere: proceedings of a symposium held in Winnipeg, Manitoba*. USDA Forest Service Gen. Tech. Rpt. NC-190, North Central Forest Experiment Station.
- Mazur, K.M., Frith, S.D. and P.C. James. 1998. Barred Owl home range and habitat selection in the boreal forest of central Saskatchewan. *The Auk* 115:746–754.
- Moeur, M., T.A. Spies, M. Hemstrom, J.R. Martin, J. Alegria, J. Browning, J. Cissel, W.B. Cohen, T.E. Demeo, S. Healey, and R. Warbington. 2005. Northwest Forest Plan—the first 10 years (1994–2003): status and trend of late-successional and old-growth forest. Gen. Tech. Rep. PNW-GTR-646. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon.
- Mote, P.W. and E.P. Salathé EP. 2009. Future climate in the Pacific Northwest. Chapter 1 in *The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate*, Climate Impacts Group, University of Washington, Seattle, Washington.

- Noon, B.R. and J.A. Blakesley. 2006. Conservation of the northern spotted owl under the Northwest Forest Plan. *Conservation Biology* 20:288–296.
- Olson, G.S., E.M. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. *Journal of Wildlife Management* 68:1039–1053.
- Olson, G.S., R.G. Anthony, E.D. Forsman, S.H. Ackers, P.J. Loschl, J.A. Reid, K.M. Dugger, E.M. Glenn, and W.J. Ripple. 2005. Modeling of site occupancy dynamics for northern spotted owls, with emphasis on the effects of barred owls. *Journal of Wildlife Management* 69:918–932.
- Oregon Administrative Rules Guidance Manuals, Division 665. 2009. Available at: <http://www.oregon.gov/ODF/privateforests/docs/guidance/OARDiv665.pdf>
- Oregon Forest Practice Act Rulebook. 2010. Oregon Department of Forestry.
- Pearson, R.R. and K.B. Livezey. 2003. Distribution, numbers, and site characteristics of spotted owls and barred owls in the Cascade Mountains of Washington. *Journal of Raptor Research* 37:265–276.
- Peterson, A.T. and C.R. Robins. 2003. Using ecological-niche modeling to predict barred owl invasions with implications for spotted owl conservation. *Conservation Biology* 17:1161–1165.
- Pierce, D.J., J.B. Buchanan, B.L. Cosentino, and S. Snyder. 2005. An assessment of the status of spotted owl habitat on non-federal lands in Washington between 1996 and 2004. Washington Department of Fish and Wildlife, Olympia, WA, USA.
- Rohner, C. 1996. The numerical response of great horned owls to the snowshoe hare cycle: consequences of non-territorial “floaters” on demography. *Journal of Animal Ecology* 65:359–370.
- Rosenberg, D.K. and R.G. Anthony. 1992. Characteristics of northern flying squirrel populations in young second- and old-growth forests in western Oregon. *Canadian Journal of Zoology* 70:161–166.
- Salathé, E.P. 2006. Influences of a shift in North Pacific storm tracks on western North American precipitation under global warming. *Geophysical Research Letters* 33, L19820, doi:10.1029/2006GL026882, 2006.
- Singleton, P.H., S. Graham, W.L. Gaines, and J.F. Lehmkuhl. 2005. The ecology of Barred Owls in fire-prone forests: 2005 progress report. Pacific Northwest Research Station, Wenatchee, WA U.S.A.
- Staus, N.L., J.R. Strittholt, D.A. DellaSala, and R. Robinson. 2002. Rate and pattern of forest disturbance in the Klamath-Siskiyou ecoregion, U.S.A. *Landscape Ecology* 17:455–470.

- Strittholt, J.R., D.A. DellaSala, and H. Jiang. 2006. Status of mature and old-growth forests in the Pacific Northwest, USA. *Conservation Biology* 20: 363:374.
- Swedeen, P.2006. Declaration of Dr. Paula Swedeen in Case No. C06-1608 MJP. Declaration in the United States District Court for the Western District of Washington. November 7, 2006. 28 pp.
- Swindle, K.A., W.J. Ripple, E.C. Meslow, and D.J. Schafer. 1999. Old-forest distribution around spotted owl nests in the central Cascade Mountains, Oregon. *Journal Wildlife Management* 63:1212-1221.
- Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl. USDA Forest Service, USDI Bureau of Land Management, USDI Fish and Wildlife Service, and USDI National Park Service. Portland, Oregon. 458 pp.
- USDA Forest Service and USDI BLM. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. USDA Forest Service and USDI Bureau of Land Management, Washington, D.C. 74 pp + attachment.
- USFWS (U.S. Fish and Wildlife Service). 1990. Endangered and threatened wildlife and plants; determination of threatened status for the northern spotted owl. *Federal Register* 55:26114–26194.
- USFWS. 1992. Recovery plan for the Northern Spotted Owl. Unpublished Report. U.S. Department of Interior, Washington, DC.
- USFWS. 2004. Northern spotted owl: Five Year Review Summary and Evaluation. USDI Fish and Wildlife Service, Portland, Oregon. 73 pp.
- USFWS. 2009. Regulatory and Scientific Basis for U.S. Fish and Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in California's Northern Interior Region..
- USFWS. 2011. Revised recovery plan for the northern spotted owl (*Strix occidentalis caurina*). U.S. Fish and Wildlife Service, Portland, Oregon.
- USFWS 2012. Experimental Removal of Barred Owls to Benefit Threatened Northern Spotted Owls. Draft Environmental Impact Statement, March 2012. U.S. Fish and Wildlife Service, Portland, Oregon.
- Van Gelder, J.J. 2003. Variation in four-note location calls of male spotted owls (*Strix occidentalis*). M.S. Thesis. Humboldt State University.

- Wagner, F.F., E.C. Meslow, G.M. Bennett, J.L. Larson, S.M. Small, and S. DeStefano. 1996. Demography of northern spotted owls in the Southern Cascades and Siskiyou Mountains, Oregon. *Studies in Avian Biology* 17:67-76.
- Ward, J.P. 2006. Declaration of Dr. James Patrick Ward, Jr. in Case No. C06-1608 MJP. Declaration in the United States District Court for the Western District of Washington. November 13, 2006. 87 pp.
- Wiens, J.D., R.G. Anthony, and E.D. Forsman. 2011. Barred owl occupancy surveys within the range of the northern spotted owl. *Journal of Wildlife Management* 75(3): 531-583.
- Woodbridge, B. 2009. Email to Chris Browder, CAL FIRE, describing “take” of Northern Spotted Owls and Inadequacy of CA Forest Practice Rules.
- Washington State Forest Practice Rules. 2012.
- Zabel, C.J., M. Brown, T. Hines, D. Thome, A. Wright, J.R. Dunk, C. Organ, and L. Leeman. 2001. Habitat associations of the northern spotted owl in the Coos Bay BLM District, Oregon. Final Report. USDA For. Serv. Pac. Southwest Res. Sta., Redwood Sciences Lab, Arcata, CA.
- Zabel, C.J., J.R. Dunk, H.B. Stauffer, L.M. Roberts, B.S. Mulder, and A. Wright. 2003. Northern spotted owl habitat models for research and management application in California (USA). *Ecological Applications* 13:1027-1040.

Additional Supporting Evidence

To demonstrate the use of Title 14 California Code of Regulations § 919.9(g)[939.9(g)] and its impacts on individual Northern Spotted Owl territories, EPIC includes our comments on THPs utilizing “Option g” since 2009, as well as the relevant accompanying sections from the THPs. In addition, for several THPs, we include correspondence from U.S. Fish and Wildlife Service to the THP submitter demonstrating that “take” of Northern Spotted Owls would occur under the implementation of the THP as allowed under “Option g.” Here we list the THPs for which we include relevant documentation:

--1-09-054HUM, 1-09-061HUM, 1-10-025HUM, 1-12-042HUM, 2-09-010TRI, 2-09-038TRI, 2-09-085TRI, 2-09-091TRI, 2-09-041TRI, 2-09-042SHA, 2-09-043TRI, 2-09-068SHA, 2-09-078LAS, 2-10-011TRI, 2-10-019TRI, 2-10-074TRI, 2-10-075TRI, 2-11-004TRI, 2-11-014TRI, 2-11-035TRI, 2-11-061TRI, 2-11-064TRI, 2-11-076SHA, 2-11-078SHA, 2-11-080TRI, 2-12-055TRI, 2-12-064TRI, 2-12-069TRI

**Regulatory and Scientific Basis for U.S. Fish and Wildlife Service
Guidance for Evaluation of Take for Northern Spotted Owls on Private
Timberlands in California’s Northern Interior Region**

Introduction

Section I: Regulatory and operational aspects of take evaluation guidelines

- A. – Regulation and definition of “take” under Endangered Species Act
 - Regulatory authority*
 - Regulatory definition of take*
 - Process for estimating the likelihood of incidental take and establishing habitat retention guidelines*
- B. – Evidence indicating that regulatory guidance in the current Forest Practice Rules are not adequate to avoid incidental take of northern spotted owls
 - New information available*
 - FWS experience in technical assistance process*
 - Analysis indicating loss of territories under Forest Practice Rules*

Section II: Summary of the FWS take evaluation guidelines

Section III: Scientific basis for NSO take evaluation guidelines

- A. – Fundamentals of northern spotted owl habitat relationships
- B. – Analysis areas
 - Home range*
 - Core area*
- C. –Quantity, distribution, and configuration of habitat
 - Home range*
 - Core area*
- D. – Habitat definitions
 - Nesting/roosting habitat*
 - Foraging habitat*
 - Abiotic habitat characteristics*
- E. – Conclusions

Introduction

In 1999, the California Department of Forestry and Fire Protection (CALFIRE) requested that the U.S. Fish and Wildlife Service (FWS) review timber harvest plans (THP) and Non-industrial Timber Management Plans to ensure that such plans would not result in incidental take of northern spotted owls (NSO). For nearly a decade, the FWS

provided this technical assistance. At first, the criteria and thresholds employed by the FWS to make our take evaluations were based on habitat retention regulations in the California Forest Practice Rules (Title 14, California Code of Regulations) (FPRs), which were originally developed collaboratively by the FWS, California Department of Fish and Game (CDFG), CALFIRE, and the California Board of Forestry. However, as knowledge of the habitat relationships of this species increased after 1992, the FWS increasingly made use of new scientific information to guide our evaluations of the potential for incidental take. The accumulation of published research results, combined with direct field experience with management of NSO and their habitat, resulted in substantial changes in the quantity and quality of habitat the FWS considered necessary to maintain continued occupancy and reproduction at NSO territories.

In 2008, the FWS returned responsibility for THP review to CALFIRE, the authorized agency under the California Environmental Quality Act. As a part of this transfer, the FWS provided CALFIRE with documentation of the criteria and thresholds currently used by the FWS in making take evaluations. This documentation, hereafter called the FWS guidelines, represents the best scientific information available to the FWS upon which to base evaluations of the likelihood of incidental take resulting from timber harvest operations in the Northern Interior Region. The FWS guidelines are not regulations and are not intended to substitute for regulations; they do, however, provide the scientific and biological foundation for reviewing proposed projects and determining the likelihood of incidental take of NSO. In this report, we provide the scientific basis for the FWS guidelines.

The habitat descriptions within the FWS guidelines were developed to enable CALFIRE personnel (who may not have extensive experience with NSO biology and habitat associations) to evaluate the likelihood of take posed by a proposed THP. This process contrasts with the technical assistance process formerly conducted by the FWS, wherein NSO experts conducted detailed evaluations of stand structure, habitat quantities, and NSO survey results to support a determination of the likelihood of take. While the FWS believes that expert review should play a central role in these evaluations, it is also true that robust habitat retention guidelines may be used to avoid take. Application of habitat retention guidelines in the absence of expert review, however, may limit managers' flexibility to classify habitat based on specific local conditions and to design harvest proposals based on these conditions.

Evaluation of the scientific bases of the FWS guidelines for NSO in the Interior Region of California (Klamath Province) is dependant on understanding the concept and regulatory definition of take, the practical and operational considerations of determining the likelihood of take, and the information supporting our conclusion that existing habitat guidelines in the FPRs are not sufficient for avoiding take. It is also important to recognize the difference between the use of habitat guidelines in the determination of take versus descriptions of desired habitat conditions for conservation of NSO.

Section I: Regulatory and operational aspects of take evaluation guidelines

A. Regulation and definition of take under Endangered Species Act

Regulatory Authority

Section 9(a)(B) of the Endangered Species Act of 1973 (ESA) prohibits the take of listed species within the United States, except as provided in section 10 of the ESA, which allows for permitted incidental take on private lands. Section 9 is intended to protect individual members of listed species.

Regulatory definition of take

The ESA defines “take” as “...to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.” The term “harm” is further defined in 50 CFR 17.3:

“Harm” in the definition of “take” in the Act means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.

Process for estimating the likelihood of incidental take and establishing habitat retention guidelines

Although the regulatory definition of take clearly expresses the intent of the ESA’s Section 9, it does not provide any metrics or criteria upon which a determination of take should be made. Because our reviews of proposed projects under section 9 are

typically conducted prior to project implementation, our determination is an estimate of the likelihood of take, based on the predicted effects of the project. Habitat retention guidelines such as those in the FPRs are intended to provide guidance as to the amount and quality of habitat that must be retained in order to avoid incidental take of NSO at sites where the species is known to occur. When the FPR guidelines were adopted in 1992, data relating habitat variables to occupancy, reproduction, and survival of NSO were limited. The FPR guidelines for avoiding incidental take of NSO were therefore based on comparison of proposed post-harvest habitat conditions with the amount and quality of habitat observed at occupied NSO sites described in various studies. Under this standard, habitat modification potentially could result in substantial reduction of reproduction, survival, and occupancy at NSO activity centers without the appearance of take, because habitat conditions still resemble other lower-quality NSO territories. NSO are known to occupy low-quality sites where their reproduction and survival are substantially reduced (Franklin *et al.* 2000, Dugger *et al.* 2005); the existence of these low-quality sites suggests that reliance on habitat conditions corresponding to the presence or absence of owls at historic territories represents a low bar for determining habitat thresholds and take.

Recent results from demographic studies of NSO in the Klamath Province provide new insights into the relationships between habitat and NSO population rates (e.g., occupancy, reproduction, and survival). By developing predictive models of these relationships, Franklin *et al.* (2000) and Dugger *et al.* (2005) introduce the concept of habitat fitness potential (HFP); “the fitness conferred on an individual occupying a territory of certain habitat characteristics” (Franklin *et al.* 2000:558). Habitat fitness

potential is a function of both the survival and reproduction of individuals within a given territory. Evaluation of habitat parameters influencing these 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. By incorporating the concept of HFP, the FWS can evaluate the predicted effects of habitat modification on fitness of NSO potentially affected by a project. Evaluation of incidental take based on habitat modification that measurably and significantly reduces the fitness of NSO within the project area (as estimated by HFP models) provides a quantitative element to our estimation of “significant impairment of breeding, feeding and sheltering” in Section 9 of the ESA. Furthermore, HFP models also provide information allowing determination of significant thresholds that may occur, such as average habitat conditions corresponding to $HFP < 1.0$ (territorial pair not replacing themselves).

Description of the structural characteristics of NSO habitat and delineation of the range of habitat conditions corresponding to essential activities such as nesting, roosting, and foraging is a critical element of developing guidelines for evaluating the likelihood of incidental take. Determination of the amount of suitable habitat that must be retained in order to avoid incidental take of NSO is strongly influenced by the range of forest conditions that are classified as suitable habitat. The HFP models of Franklin *et al.* (2000), Olson *et al.* (2004), and Dugger *et al.* (2005) contain a limited number of habitat variables and relatively coarse definitions of NSO habitat, and therefore must be supplemented with additional information on forest structural parameters that support classification of forest habitat as suitable for nesting and foraging. Because the

structural attributes of habitat immediately surrounding nests are easily quantified, data supporting classification of nesting habitat are readily available (see section III.C). Foraging habitat, on the other hand, is more variable and spatially extensive, requiring intensive radio-telemetry studies to measure use of various habitat conditions by NSO. In recent studies by the National Council for Air and Stream Improvement (NCASI), correlations between habitat data from detailed forest inventories and nocturnal locations of radio-tagged NSO and California spotted owls were used to estimate resource selection function (RSF) models (Irwin et al. 2007a,b) that quantify complex relationships between the owls and their environment. These models allow evaluation of the relative use of specific forest structural variables, such as tree size class distribution and stand density, by foraging NSO. The studies of Irwin *et al.* (2007), combined with other telemetry studies (Solis and Gutierrez 1990), provide the basis of our definitions of suitable foraging habitat for NSO in the Northern Interior Region.

Criticism of the THP review process is frequently focused on the use of “thresholds” that simplify complex gradients of habitat quality into a single value (e.g., 40% suitable habitat within 1.3 mile radius, or 185 ft² of basal area). The FWS has long recognized that many different combinations of habitat structure and amount may support a viable NSO territory; evaluation of these combinations by technical experts has been our primary role in technical assistance. However, to maintain consistency and incorporate new information it is necessary to implement unambiguous habitat standards and criteria (i.e., thresholds) that delineate conditions under which take is deemed unlikely. Thresholds do not represent arbitrary lines through consistent data sets; rather, they represent the preponderance of evidence derived from careful evaluation of the

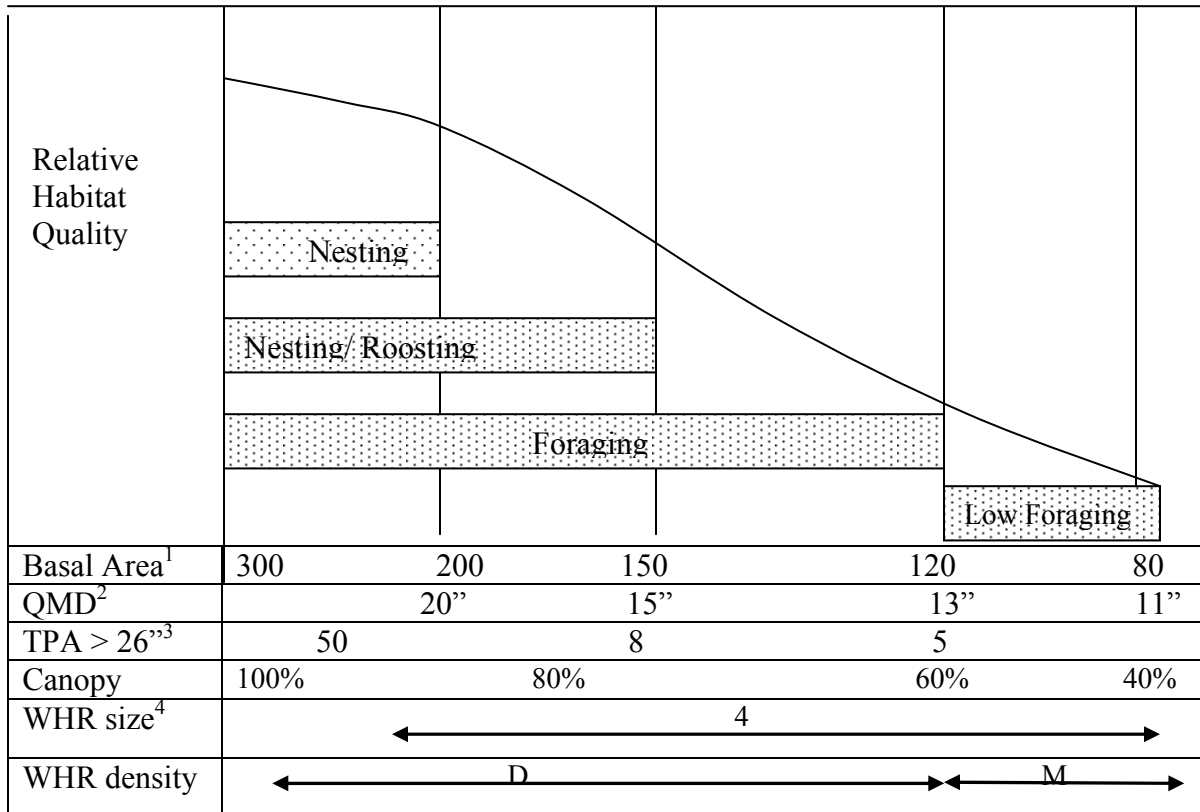
results and conclusions of many published studies, supplemented by data sets from credible sources.

Derivation of habitat thresholds from published studies consists of two consecutive steps. First, we consider the relationship or trend between habitat features and spotted owls. For example, most studies show that habitat use by foraging NSO is positively correlated with increasing tree size. These consistent, statistically significant relationships then serve as the foundation for subsequent choice of habitat values that correspond with viable NSO territories. We emphasize habitat parameters that receive disproportionate use by NSO, or are correlated with fitness. In this second step, we evaluate the pattern and distribution of data from a wide range of sources and attempt to identify ranges of values that correspond to consistent use. Deriving the central tendencies within complex, inconsistent data is a difficult task, and often requires input from the researchers responsible for published studies.

Despite consistent patterns of habitat selection by NSO, structural conditions of forest habitats occupied by NSO are highly variable, particularly in the diverse conifer-hardwood forests of the Klamath Province. We recognize that habitat retention guidelines must incorporate the range of habitat conditions used by NSO for nesting, roosting, and foraging, while at the same time ensuring that habitat conditions are not degraded to the point where significant impairment of breeding, feeding, and sheltering occurs. The FWS guidelines achieve this balance and provide a robust method for evaluating the likelihood of take because they describe a range of habitat conditions representing the central tendency for high-quality nesting habitat, nesting roosting

habitat, foraging habitat, and low-quality foraging habitat that may provide prey resources (Fig. I.A.1).

Figure I.A.1: Conceptual model of spotted owl habitat functions, relative habitat quality, and associated forest structural conditions.



¹ Square feet per acre, ²Quadratic Mean Diameter of trees >5"dbh, ³ Trees per acre greater than 26" diameter at breast height, ⁴ California Wildlife Habitat Relationships System

This process must be distinguished from the simple application of “minimum habitat standards” that correspond to the lowest denominator of observed habitat use. To illustrate this, Figure I.A.1 depicts the relationship between California Wildlife Habitat Relationships system (WHR) class 4M and relative use of habitat by NSO. The FPRs classify 4M stands as suitable for nesting, roosting, and foraging by NSO. Although 4M encompasses a wide range of stand conditions, some of which may be suitable as

foraging habitat, it largely consists of stand conditions rarely used by NSO. For this reason, the use of existing minimum habitat standards such as those currently in the FPRs may result in take of NSO and are insufficient for programmatic use in take avoidance reviews of THPs.

B. Evidence indicating that regulatory guidance in the current Forest Practice

Rules is not adequate to avoid incidental take of NSO

New information available

The current FPRs governing habitat retention for NSOs were developed in 1992 and predate much of the published research used in the FWS guidelines. In particular, studies correlating habitat and NSO fitness measures, and radio-telemetry studies of habitat use by foraging NSO (Irwin *et al.* 2007b) provide information directly applicable to evaluation of timber harvest-related impacts to NSO. During the past decade, the FWS has incorporated the results of new research into Technical Assistance on a plan by plan basis. However, with the February 2008 return of THP review to CALFIRE, the large number of recently published studies requires that a full synthesis of current knowledge be conducted and incorporated into updated take evaluation guidelines. This synthesis, and the habitat retention guidelines that it supports, are presented in section III of this report.

FWS experience in technical assistance process

The FWS' primary source of information regarding habitat conditions and NSO status on industrial timberlands in the Northern Interior Region has been our review of

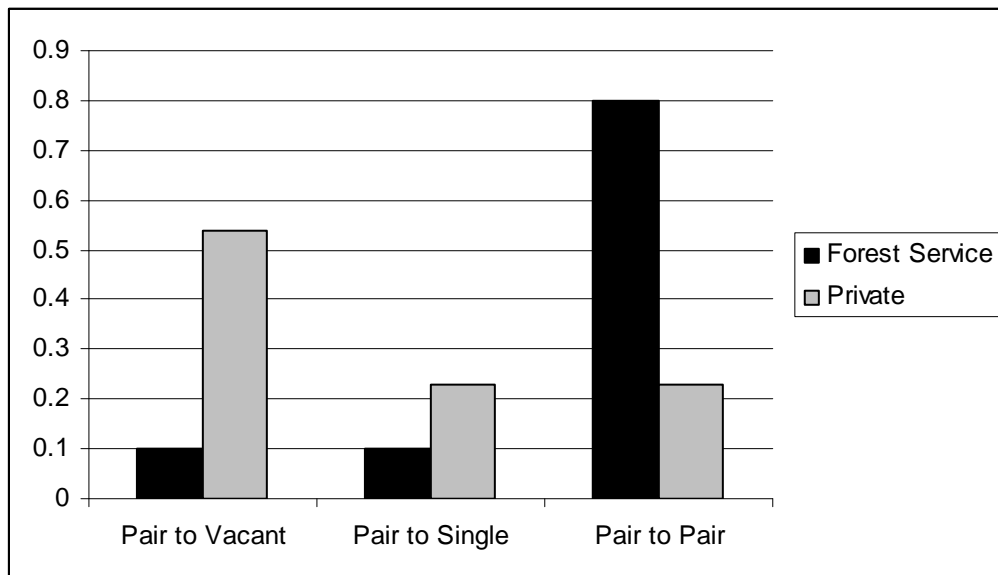
THPs. In the THP review process, FWS staff carefully evaluated historical NSO records and results of current surveys conducted in the plan area, as well as the habitat data provided in support of the THP. In cases where timber harvest was proposed in close proximity to an NSO activity center, the FWS evaluated habitat conditions in the field. The THP review process was conducted on a plan-by-plan basis, which does not permit systematic assessment of habitat conditions and NSO status across an entire ownership. However, 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 CALFIRE 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. This highlights the need for refined, objective criteria to determine the likelihood of NSO take when assessing THPs.

Analysis indicating loss of territories under Forest Practice Rules

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.

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



Section II: Summary of the FWS NSO Take Evaluation Guidelines

The FWS guidelines provide a step-by-step process for evaluation of the likelihood of incidental take posed by proposed THPs (Appendix A). The steps include: (1) verifying the accuracy of NSO activity center location and status; (2) reviewing survey coverage and results to determine whether protocol has been met; and (3) evaluating the quantities and quality of habitat to be retained at each NSO home range potentially affected by the proposed THP. To assist the reader, this section briefly summarizes the analysis areas, habitat quantities, and habitat definitions used in step (3) of the FWS guidelines. See Appendix A for the full take avoidance analysis guidance provided to CALFIRE.

The FWS guidelines specify three spatial scales that form appropriate analysis areas for evaluation of habitat at NSO home ranges. The fourth analysis area, the ‘outer core’ represents the area between the core area and the total home range area (Table II.1). Within each analysis area, the FWS guidelines describe the quantities of habitat that must be retained in each of four functional habitat categories to avoid incidental take of NSO. These categories are: (1) high-quality nesting/roosting habitat; (2) nesting/roosting habitat; (3) foraging habitat; and (4) low-quality foraging habitat (Table II.2). Descriptions of the stand structural attributes corresponding to each functional habitat category are given in Table II.3. Table II.4 provides additional considerations for use in prioritizing habitat areas for retention.

Table II.1: Spatial scales used to evaluate habitat conditions at northern spotted owl activity centers in the Northern Interior Region

Analysis Area	Radius	Area
Nest Site	1000 feet	70 acres
Core Area	0.5 mile	502 acres
Outer Ring	0.5 – 1.3 mile	2,908 acres
Home Range	1.3 miles	3,410 acres

Table II.2: Minimum quantities of habitat to be retained within four functional habitat types to avoid incidental take of northern spotted owls on private timberlands in the Northern Interior Region

Analysis Area	Functional Habitat Type				
	High-quality NR	Nesting/ Roosting	Foraging	Low-quality Foraging	Total Suitable
Core area	100 acres	150 acres	100 acres	50 acres	300 acres
Outer 'ring'			655 acres	280 acres	935 acres
Home range (total)	100 acres	150 acres	755 acres	330 acres	1335 acres

Table II.3: Values for selected stand structural parameters used to classify nesting/roosting and foraging habitat for northern spotted owls in the Northern Interior Region

Parameter	Functional Habitat Type			
	High-quality NR	Nesting/Roosting	Foraging	Low-quality Foraging
Basal area	$\geq 210 \text{ ft}^2/\text{acre}$	Mix ranging from 150 to $\geq 180 \text{ ft}^2/\text{acre}$	Mix ranging from 120 to $\geq 180 \text{ ft}^2/\text{acre}$	Mix ranging from 80 to $\geq 120 \text{ ft}^2/\text{acre}$
Quadratic mean diameter	≥ 15 inches	≥ 15 inches	≥ 13 inches	≥ 11 inches
Large trees per acre	≥ 8	≥ 8	≥ 5	NA
Canopy closure	$\geq 60\%$	$\geq 60\%$	\geq Mix ranging from 40 to 100%	$\geq 40\%$

Table II.4: Guidelines for prioritizing habitat to be retained to avoid incidental take of northern spotted owls on private timberlands in the Northern Interior Region

Tree Species composition	Mixed conifer stands should be selected over pine-dominated stands
Abiotic considerations	
Distance to nest	Nesting/roosting and foraging habitat closest to identified nest trees, or roosting trees if nest unknown
Contiguity	Nesting/roosting and foraging habitat within the 0.5 mile radius must be as contiguous as possible
	Minimize fragmentation of foraging habitat as much as possible
Slope position	Habitats located on the lower 1/3 of slopes provide optimal microclimate conditions and increased potential for intermittent or perennial water sources
Aspect	Habitats located on northerly aspects provide optimal vegetation composition and cooler microclimates
Elevation	Habitat should be at elevations < 6000 feet, lower elevations are preferred

Section III: Scientific Basis for NSO Take Evaluation Guidelines

A. Fundamentals of spotted owl habitat relationships

Northern spotted owls exhibit clear, consistent patterns of habitat association, and these associations must provide the foundation of habitat management guidelines. In the 1990 *Conservation Strategy for the Northern Spotted Owl*, the Interagency Scientific Committee (Thomas *et al.* 1990) stated that:

“With the exception of recent studies in the coastal redwoods of California, all studies of habitat use suggest that old-growth forests are superior habitat for northern spotted owls. Throughout their range and across all seasons, spotted owls consistently concentrated their foraging and roosting in old-growth or mixed-age stands of mature and old-growth trees....Structural components that distinguish superior spotted owl habitat in Washington, Oregon, and northwestern California include: a multilayered, multispecies canopy dominated by large (>30 inches dbh) conifer overstory trees, and an understory of shade-tolerant conifers or hardwoods; a moderate to high (60-80 percent) canopy closure; substantial decadence in the form of large, live coniferous trees with deformities- such as cavities, broken tops, and dwarf mistletoe infections; numerous large snags; ground cover characterized by large accumulations of logs and other woody debris; and a canopy that is open enough to allow owls to fly within and beneath it.”

Fifteen years later, the conclusions of the Interagency Scientific Committee were echoed in the *Scientific Evaluation of the Status of the Northern Spotted Owl* (Courtney *et al.* 2004), who found that the habitat attributes identified by Thomas *et al.* (1990) remain important components of NSO habitat. Notably, positive relationships were found with the aforementioned attributes whether the samples of owl and random locations were

within old-growth forest, non-old growth forest, National Parks, public land, private land, or an Indian Reservation. In 2008, the *Recovery Plan for the Northern Spotted Owl* (USFWS 2008) again reiterated the association of NSO with older forest conditions, stating; “Spotted owls generally rely on older forested habitats (Carroll and Johnson 2008) because such forests contain the structures and characteristics required for nesting, roosting, and foraging.” A major advance in our understanding of NSO habitat relationships from Thomas et al. (1990) to the present is that we now have a much better understanding of the spatial scale of habitat selection (Hunter et al. 1995), Meyer et al. 1998, Zabel et al. 2003) and relationships of habitat to owl fitness (Franklin et al. 2000, Dugger et al. 2005).

III.B: Analysis Areas

Management guidelines for territorial organisms are typically spatially explicit; that is, they apply to an area corresponding to the movements and activity patterns of the individuals occupying a territory. Spotted owls are territorial raptors that range widely in search of prey but are ‘anchored’ during the breeding season to a nest site (central-place forager). Evaluations of NSO habitat are usually conducted at two spatial scales; the home range and core areas. The home range is the “area traversed by the individual in its normal activities of food gathering, mating, and caring for young” (Burt 1943:351). Within home ranges, areas receiving concentrated use, typically surrounding the nest site and favored foraging areas, are called core areas. Because the size and pattern of NSO space use are typically unknown, estimates of use areas are derived from radio-telemetry studies. The analysis areas employed in the FWS guidelines are based on a subset of

estimates that describe the outer perimeter of NSO activity areas, thus incorporating the areal extent most likely to contain important resources. In this section we review and summarize information related to home range size and patterns of space use within home ranges by NSO.

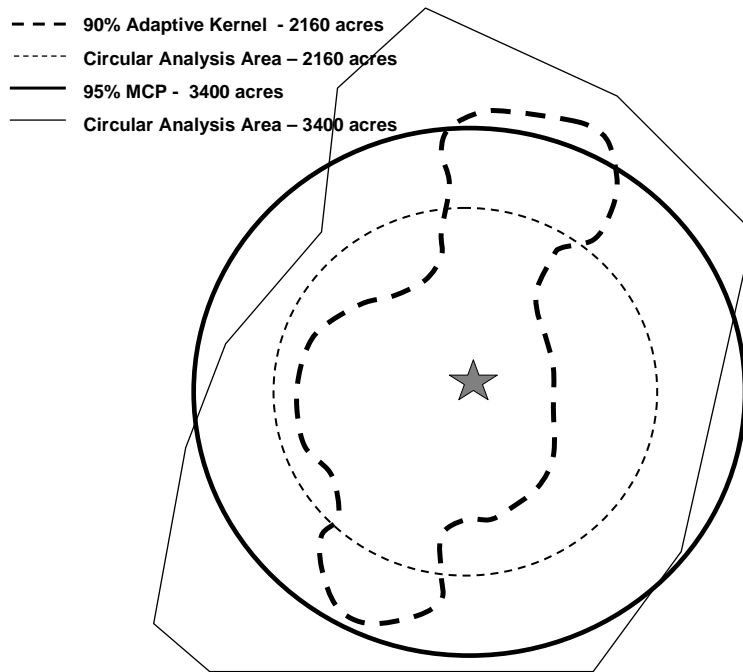
Home Range (1.3-Mile-Radius, 3,410-Acre) Analysis Area

The FPR guidelines for avoiding take of NSOs during timber operations in the Klamath Province indicate the amount of habitat to be retained within 1.3 miles of activity centers. The size of this area was originally based on estimated median annual home range sizes for NSO pairs in northern California, Oregon, and Washington (Thomas *et al.* 1990, USFWS 1992). There are numerous analytical techniques for estimating home range sizes based on animal locations (reviewed in Powell 2000). One of the most commonly used classes of home range estimators is the minimum convex polygon (MCP). Because MCP consists of a single polygon encompassing all or the majority of telemetry locations, this method may be viewed as providing a representation of the area *containing* the home range, including unused and infrequently used areas (Powell 2000, Laver and Kelly 2008). Generally biased large, MCP home range estimates provide relatively conservative values on which to base the size of habitat-analysis areas. Other home range estimators such as utilization distributions (e.g., kernel density estimates: see Powell 2000) de-emphasize areas less frequently used and typically yield smaller home range estimates that, when converted into circular analysis areas, may exclude distant, but potentially important, patches of habitat (see Figure 2.b.1). At the upper end of utilization distributions (e.g.; 90-100%), however, kernel estimates may resemble MCP polygons and circular analysis areas (Anthony and Wagner 1999).

Estimates of home range size are also important for developing management prescriptions and evaluating impacts of human activities on NSO. For the purpose of quantifying habitat and the impact of proposed modification of habitat, median home range estimates from radio telemetry studies are transformed into circular ‘analysis areas’ that are used as surrogates for actual home ranges (Fig. 2.b.1). Based on the median MCP home range estimate for NSO pairs in the Klamath Province, the FWS currently uses a circular analysis area of 1.3 mile radius (3,398 acres; Thomas *et al.* 1990, USFWS 1992). While this practice provides a practical and uniform method for quantifying NSO habitat, circular analysis areas will generally not correspond directly with areas actually used by NSO. Landscape pattern, both in terms of topographic features and vegetation pattern; prey distribution, abundance and availability; as well as distribution and/or abundance of competitors and predators are all likely to influence NSO territory and home range shape (Anthony and Wagner 1999).

Our understanding of space use by NSO is limited by lack of comparability among published studies due to variation in estimation methods, duration and seasonality of data collection, and whether estimates are for individuals or pairs. By looking for commonalities among studies and using a “strength of evidence” approach, however, we can evaluate whether the available information provides broadly modal values that are useful for conservation planning. Because the primary purpose of this review is to evaluate appropriate spatial scales for evaluation of effects to territorial paired NSO, we have focused on conservative estimates of year-round (annual) space use by NSO pairs.

Figure III.B.1: Comparison of MCP and adaptive kernel home range estimates with corresponding circular analysis areas at an actual northern spotted owl home range.



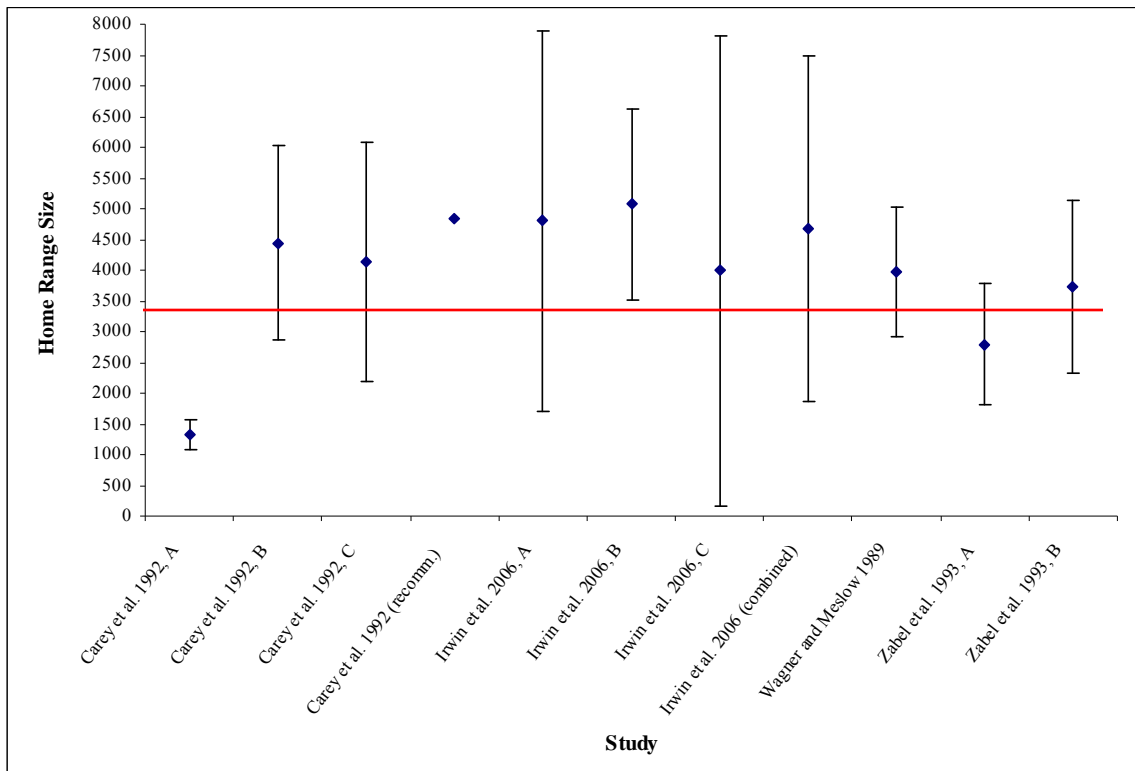
The sizes of NSO home ranges are influenced by a variety of factors, including geographic differences in diets and habitat characteristics (Carey *et al.* 1992, Zabel *et al.* 1995). Therefore, we restricted our assessment of the validity of the 1.3-mile-radius analysis area to home range studies conducted within the Klamath Province. Because the outer analysis area should be large enough to include habitat needed to meet all major life history requirements and should accommodate areas important to both members of most pairs, we largely restricted our evaluation to studies that provided MCP estimates of the sizes of home ranges used year-round by pairs or paired individuals.

Home range studies conducted in the Klamath Province after the FPR guidelines were formulated support the use of a 1.3 mile radius analysis area, as this distance is encompassed by the confidence intervals of nearly all the home range studies we

compiled. (see Figure III.B.2). Carey *et al.* (1992) found that the sizes of NSO pairs' home ranges were related to the type of forest and the degree of forest fragmentation (Table III.B.1). Pairs' home ranges in clumped, old forest were substantially smaller than the 1.3-mile-radius analysis area, whereas those in fragmented forest were somewhat larger than the analysis area. The authors suggested that management areas should be slightly larger than 1.3 miles, however, to encompass oblong-shaped home ranges. Zabel *et al.* (1993) provided estimates of 21 pairs' home ranges in two different study areas in the region (see Table III.B.2). They did not report the sizes of pairs' annual home ranges, but the average sizes of pairs' nonbreeding season home ranges were similar to the size of the FWS guidelines' outer analysis area. Pairs' annual home ranges would likely be larger than these values because their breeding- and nonbreeding-season home ranges probably do not completely overlap. In a different study, the mean cumulative pair MCP home range size for 9 pairs in the Medford, Oregon area was 3,971 acres (SD=1,063 acres), which is also similar to the 1.3-mile radius analysis area (Wagner and Meslow 1989). A fourth study by Irwin *et al.* (2006) showed greater mean home range sizes for 3 study areas in the region than the 1.3-mile radius analysis area used in the existing FWS guidelines (see Table III.B.3). The FWS recognizes that because of differences in methodology between these studies and those originally used to support the 1.3-mile radius analysis area (see Thomas *et al.* 1990, USFWS 1992), the results cannot be rigorously compared (see Powell 2000, Laver and Kelly 2008). Nonetheless, mean MCP values for home range area from more recent studies suggests that the outer analysis area should be somewhat larger than the 1.3-mile (3,410-acre) guideline (Figure III.B.2). We elected to retain the current guideline because, 1) the high degree of variability in MCP

estimates in Figure III.B.2 does not compel us to reject the home range estimate in our existing guidelines in exchange for any particular alternative size, and 2) disproportionately high use of habitats closer to nest sites by NSO (see core areas, below) leads us to emphasize habitat conditions closer to nests, rather than expanding home range area.

Figure III.B.2: Mean Minimum Convex Polygon home range sizes (acres) for northern spotted owls in the Klamath Province, CA and OR. Error bars represent ± 1 standard deviation. Horizontal line shows the size of the Fish and Wildlife Service guidelines' outer analysis area (3,410 acres).



Carey et al. 1992 = pairs' annual home ranges, A = Klamath Mountains, clumped forest, B = Klamath Mountains, fragmented forest, C = Umpqua, fragmented forest; Irwin et al. 2006 = paired-individuals' annual home ranges, A = Hilt, B = Medford, C = Yreka; Zabel et al. 1993 = pairs' nonbreeding-season home ranges, A = Mad River, B = Ukonom.

Table III.B.1: Minimum Convex Polygon estimates of annual home range sizes (acres) for northern spotted owl pairs within different types of forest in the Klamath Province, Oregon (Carey *et al.* 1992)

Area*	No. Pairs	Mean	SE
MCC	3	1317	143
MCF1	5	4139	870
MCF2	6	4438	645
Recommended	-	4843	-

*MCC = mixed-conifer, clumped, Klamath Mountains old forest; MCF1 = mixed-conifer, fragmented, Umpqua River Valley, old forest; MCF2 = mixed-conifer, fragmented, Klamath Mountains old forest.

Table III.B.2: Minimum Convex Polygon (100%) estimates of home range sizes (acres) for northern spotted owls in the Klamath Province, California (Zabel *et al.* 1993)

Study Area	<u>Mad River</u>		<u>Ukonom</u>	
	Mean	SD	Mean	SD
<u>Individuals</u>				
NB*	1989	890	2572	857
B*	1043	447	1460	578
A*	2456	1124	2847	1374
<u>Pairs</u>				
NB*	2787	986	3721	1409
B*	1436	368	1900	756

*NB = nonbreeding season home range; B = breeding season home range; A = annual home range.

Table III.B.3: Estimated cumulative (100%Minimum Convex Polygon) home range sizes (acres) for selected* territorial individual northern spotted owls in the Klamath Province, California (Irwin *et al.* 2006)

Study Area	<u>Yreka</u>	<u>Medford</u>	<u>Hilt</u>	<u>Combined</u>
No. Individuals	7	9	10	26
Mean	3987	5073	4805	4678
SD	3819	1557	3098	2816

*Excludes owls that did not exhibit normal ranging behavior (i.e., moved to new territory, or influenced by active timber harvest).

Core Area (0.5-Mile-Radius, 500-Acre) Analysis Area

The FPR guidelines for avoiding take of NSO during timber operations specified the amounts of habitat to be retained within 0.7 mile (986 acres) of activity centers. The 0.7-mile-radius scale was adopted in the FPR guidelines based on a study by Thomas *et al.* (1990), who found that circles of this size surrounding NSO nest sites contained significantly more suitable habitat compared with random circles. This study, however, only illustrated the importance of suitable habitat, rather than the amount of habitat required by NSO or the appropriate scales for evaluating and managing habitat (Bart 1995). The results of studies conducted after the FPR guidelines were formulated (see below) have indicated that a 0.5-mile-radius (500-acre) area around activity centers is a more appropriate scale at which to evaluate the amounts of habitat required by breeding NSO in the Klamath Province. These studies provide three primary lines of support for the core area size used in the FWS guidelines; distribution of locations of radio-telemetered NSO, territorial spacing of NSO, and studies comparing relative habitat selection at different scales.

Resources such as food and breeding and resting sites are patchily distributed in heterogeneous landscapes, such as those prevalent within the Klamath Province. In such landscapes, animals are likely to disproportionately use areas that contain relatively high densities of important resources (Powell 2000). These disproportionately used areas are referred to as core areas. One of the most influential studies of wildlife core areas was focused on NSOs in northern California (Bingham and Noon 1997). Although this study's sample size was small, it used an unusually rigorous method for determining the sizes of core areas (Powell 2000). Bingham and Noon (1997) noted that the combined

size of NSO pair members' core areas is probably more meaningful than the sizes of individuals' core areas. Bingham and Noon (1997) estimated core areas by evaluating the ratio of total home range area to the area encompassing different adaptive kernel utilization distributions (UD), and found that individual NSO in northern California spent 60 to 75% of their time in their core areas, which comprised only 21 to 22% of their home ranges. The mean core area size for NSO pairs in the Klamath Province was 411 acres (166 ha; SE=26 ha; range=168-455 acres [68-184 ha]; n=7 pairs). Bingham and Noon (1997) also recommended that management guidelines attempt to meet the area requirements of most individuals in a population by accounting for variability in core area size; for example, by using the mean core area size plus one standard error. The addition of one standard error to the mean size of pairs' core areas totaled 475 acres (192 ha) for the Klamath Province data set. NSO core areas had diverse shapes due to variation in the distribution of foraging and roosting locations (Bingham and Noon 1997). However, assuming a circular shape for the purposes of evaluating and managing habitat, an area this size would have a radius of 0.49 mile. Carey and Peeler (1995) found remarkably similar results outside the Klamath Province, in southern Oregon.

We evaluated home range estimates from other studies in the Klamath Province in light of these patterns. By approximating Bingham and Noon's (1997) methodology, we evaluated kernel estimates in Irwin et al. (2004; Table 2) to estimate core area size (only 50%, 75% and 95% UD estimates were available). The 75 percent fixed kernel estimate accounted for 21 to 27 percent of the total (95%) home range, and the 75 percent adaptive kernel accounted for 23 to 30 percent, suggesting that a UD somewhat lower than 75 percent would yield core area estimates very similar to those obtained by Bingham and

Noon (1997). The addition of one standard error to individuals' mean 50 percent and 75 percent kernel density home range estimates from three different study areas in the province suggested that 500-acre analysis areas would include much of the important habitat for most breeding NSOs (Irwin *et al.* 2004, Table 2.b.4). Application of the same criteria to the results of a telemetry study in southwestern Oregon suggested that pairs used somewhat larger core areas than in other parts of the Klamath Province (Anthony and Wagner 1999, Table 2.b.5). Much of this study area is comprised of a checkerboard of public lands and industrial timberlands (Anthony and Wagner 1999, Dugger *et al.* 2005). To the extent that the amounts, quality, or contiguity of habitat have been reduced on these timberlands due to timber harvesting, NSO in this area may have larger area requirements than in parts of the province with less harvesting (Carey *et al.* 1990, 1992, Zabel *et al.* 1992, 1995).

Table III.B.4: Fixed kernel and adaptive kernel cumulative home range estimates (acres) for individual NSOs in the Klamath Province (Irwin *et al.* 2004).

Study Area	<u>Yreka</u>	<u>Medford</u>	<u>Hilt</u>	<u>Combined</u>
No. Individuals	9	10	11	30
No. Telemetry Points	3151	5041	2414	10606
<u>50% Fixed Kernel</u>				
Mean	128	210	147	162
SE	18	26	22	14
Mean + 1 SE	146	236	169	176
<u>75% Fixed Kernel</u>				
Mean	364	510	435	439
SE	38	47	54	29
Mean + 1 SE	402	557	489	468
<u>50% Adaptive Kernel</u>				
Mean	239	303	262	269
SE	47	39	42	24
Mean + 1 SE	286	342	304	293
<u>75% Adaptive Kernel</u>				
Mean	584	706	673	657
SE	124	68	91	54
Mean + 1 SE	708	774	764	711

Table III.B.5: Adaptive kernel home range estimates (acres) for NSO pairs in southwestern Oregon (Anthony and Wagner 1999).

Utilization Distribution	50%	75%
Mean	413	1443
SE	67	259
Mean + 1 SE	480	1702

The territorial spacing of NSO provides additional support for using a 0.5-mile-radius core area to evaluate and manage habitat for NSO in the Klamath Province. An individual's territory is thought to be the portion of the home range that both contains important resources and is economically defensible (Meyer *et al.* 1998). Therefore, average territory size provides a useful scale at which to evaluate core area habitat.

Wildlife biologists frequently use half the mean or median nearest neighbor distance to estimate the size of the defended portions of home ranges, or the portions of home ranges that are used exclusively by resident pairs (e.g., Reynolds and Joy 1998). Half the mean and median nearest neighbor distances for nesting NSO near Willow Creek were 0.49 mile (0.79 km: Hunter *et al.* 1995) and 0.44 mile (0.71 km: Franklin *et al.* 2000), respectively.

A third line of support for using a 0.5-mile-radius area for evaluating and managing habitat is provided by studies that modeled the habitat relationships of NSOs in the Klamath Province. Two studies in the region found that habitat within a 0.5-mile radius of nests differed more strongly from the general landscape compared with larger areas around nests (Hunter *et al.* 1995, Meyer *et al.* 1998, Zabel *et al.* 2003). While these results do not necessarily indicate that NSO are most selective of habitat at the 0.5-mile-radius scale, they do show that evidence of habitat selection by NSO is weaker at scales larger than this. Stronger support for the validity of assessing and managing habitat at the 0.5-mile-radius scale is provided by studies that modeled habitat-based fitness (Franklin *et al.* 2000, Dugger *et al.* 2005) and presence (Zabel *et al.* 2003) for NSO in the region. These studies found that important NSO-habitat relationships were well-captured at scales of 0.44 to 0.50 mile around activity centers.

III.C: Quantity, Distribution, and Configuration of Habitat

The FPR take-avoidance guidelines required that 40% of the 1.3-mile-radius analysis area and 50% of the 0.7-mile-radius analysis area be retained as suitable habitat. The FWS guidelines kept the 40% requirement because it is consistent with the results of

research in the Klamath Province. However, the FWS guidelines require greater concentration of habitat near the nest or activity center than did the FPR guidelines. This concentration occurs through: (1) a decrease in the size of the inner analysis area (from 0.7- to 0.5-mile radius; see *Analysis Areas*) and (2) requirement that part of the total amount of foraging habitat (see *Habitat Definitions*) in the home range be retained within the inner analysis area. These changes are supported by studies conducted in the Klamath Province after the FPR guidelines were formulated.

Several types of information are available for evaluating the quantities, distribution, and configuration of habitat that must be retained in order to avoid take of NSO. The strongest type of information relevant to evaluation of take relates the fitness of NSO to characteristics of their habitat (Franklin *et al.* 2000, Olson *et al.* 2004, Dugger *et al.* 2005). Habitat-based fitness, or habitat fitness potential (HFP), is “the fitness conferred on an individual occupying a territory of certain habitat characteristics” (Franklin *et al.* 2000:558). HFP is a function of both the survival and reproduction of individuals within a given territory. Habitat-based modeling that accurately predicts the presence (“occupancy”) of breeding NSO (Zabel *et al.* 2003) is another important tool for evaluating the species’ habitat relationships. This modeling assumes that NSO gravitate toward areas likely to confer high fitness but does not directly relate habitat characteristics to the survival and reproduction of owls. Descriptions of areas around nests, and comparisons between them and random areas, are additional sources of information for investigating NSO-habitat relationships. This approach provides information about the habitat associations and preferences of NSO but must be cautiously considered because it does not relate habitat descriptions to the fitness of owls. For

example, the average quantity of habitat around a sample of NSO nests could be higher than what is available around random locations, but still be lower than what is required for persistence of individuals or the population.

Comparisons among habitat studies can be problematic because researchers often define habitat differently and use different source data to classify vegetation (see Table III.C.1). Nonetheless, all studies in the Klamath Province have found that NSO exhibit strong relationships with older, more structurally complex, conifer-dominated forest classes. The concordance of these findings enabled the FWS to evaluate the guidelines relative to the quantities, distributions, and configurations of older forest within analysis areas. Spotted owls also forage within intermediate (younger and/or more open) forest classes (see *Habitat Definitions*, below). One study (Zabel *et al.* 2003; see below) found a positive association between NSO in the Klamath Province and moderate amounts of intermediate forest (see Table III.C.1) at the core area scale. This habitat class was based on conditions known to be used by foraging NSO. Other studies in the region have described the proportions of analysis areas comprised of intermediate forest classes but have not found positive associations between them and NSO. These forest classes often included conditions that receive little or no use by NSO, however, and are therefore not directly comparable with foraging habitat as defined by Zabel *et al.* (2003) and the FWS guidelines (see *Habitat Definitions*, below). There is currently no information for evaluating the proportion of intermediate forest that should be retained at the home range scale in order to avoid take of NSO in the Klamath Province.

Table III.C.1: Descriptions of suitable or selected habitat from studies of northern spotted owl-habitat relationships in the Klamath Province

Study	Location	Classification Method	Description of Selected or Suitable Habitat
USFWS 1992, Bart 1995	Washington, Oregon, northern California	research synthesis (various methods)	conifer-dominated forest with a multi-layered canopy, average DBH ¹ >30 inches, ≥60% canopy cover, decadence (snags, logs, deformed trees)
Anthony and Wagner 1999	southwestern Oregon	aerial photographs, ground reconnaissance	conifer-dominated forest with a multi-layered canopy, ≥40% canopy cover, decadence, large snags and logs; characterized by trees ≥30 inches DBH and ≥200 yrs
Carey <i>et al.</i> 1992	southwestern Oregon	aerial photographs, forest inventory data, ground reconnaissance	multi-layered canopy, average DBH of dominant trees >39.4 inches, large snags and logs
Dugger <i>et al.</i> 2005	southwestern Oregon	aerial photographs, ground reconnaissance	conifer or mixed forest, ≥100 yrs; characterized by trees ≥13.8 inches DBH
Franklin <i>et al.</i> 2000	northwestern California	satellite imagery	forest comprised of ≥40% conifers, conifer QMD ² ≥21 inches, hardwood QMD ≥6 inches, canopy cover ≥70%
Gutiérrez <i>et al.</i> 1998	northwestern California	satellite imagery	≥30% canopy cover, >50% of conifer basal area comprised of trees ≥21 inches DBH
Hunter <i>et al.</i> 1995	northwestern California	satellite imagery	≥30% canopy cover, >50% of conifer basal area comprised of trees ≥21 inches DBH
Meyer <i>et al.</i> 1998	western Oregon	aerial photographs	conifer-dominated forest, trees ≥80 yrs and/or multi-layered canopy
Ripple <i>et al.</i> 1997	southwestern Oregon	aerial photographs	conifer-dominated forest, average DBH ≥19.7 inches, canopy cover ≥60%
Solis and Gutiérrez 1990	northwestern California	timber type classification	average DBH >20.7 inches
Zabel <i>et al.</i> 1993	northwestern California	topographic maps, aerial photographs, and orthophotoquads	stands dominated (in terms of basal area) by trees >20.9 inches DBH; >20% canopy cover of dominant trees and >70% canopy cover of trees >5.1 inches DBH
Zabel <i>et al.</i> 2003	northwestern California	modified timber type classification, varied geographically	<u>nesting-roosting habitat</u> : for most locations average DBH ≥17 inches and average conifer canopy cover ≥60%; <u>foraging habitat</u> : in all locations average DBH ≥9.8 inches and average conifer canopy cover ≥40%, additional criteria in some locations

¹ DBH: Diameter at breast height

²QMD: Quadratic mean diameter

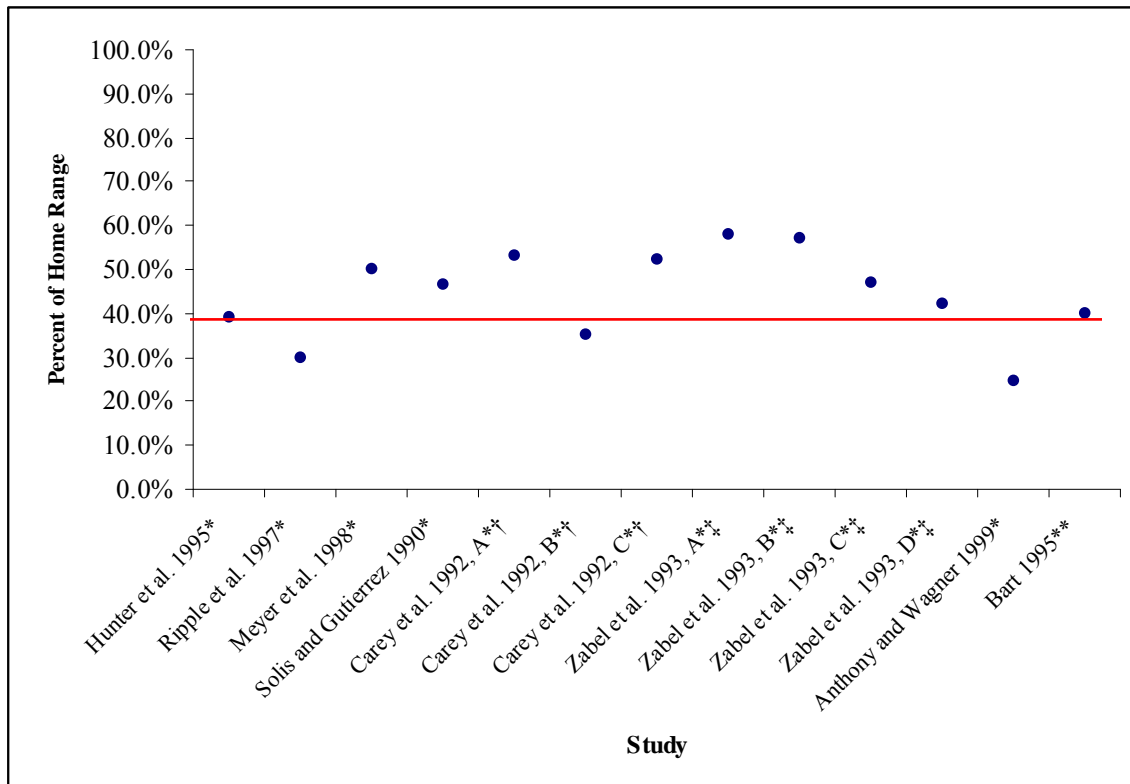
Home Range (1.3-Mile Radius)

Bart (1995) evaluated the 1992 draft recovery plan's (USFWS 1992) requirement that at least 40 percent of the estimated home range be retained as suitable habitat. Using demographic data from throughout the NSOs' range, including the Klamath Province, he calculated that populations are stable when the average proportion of suitable habitat in home ranges is 30 to 50 percent. In a related comment on the FPR take-avoidance guidelines, Bart (1992:3) noted that "...lambda probably reaches 1.0 (stable population) when suitable habitat declines to somewhere between 40 and 55 percent. Since the Service must have good evidence that take did occur, not just that it might have occurred, using a value of 40 percent seems reasonable." Bart's (1992) conclusions continue to be supported by the results of recent research.

Studies have reported a wide range of mean proportions of older forest (ca. 24 - 58 percent; see Figure III.C.1) in home range-sized areas around NSO nests or roosts in the Klamath Province and adjacent areas (Solis and Gutiérrez 1990, Carey *et al.* 1992, Zabel *et al.* 1993, Hunter *et al.* 1995, Ripple *et al.* 1997, Meyer *et al.* 1998, Anthony and Wagner 1999). Variation in proportions of habitat was likely due to multiple factors, particularly differences in habitat classification (see Table III.C.1), but also including sizes of analysis areas and study season (i.e., breeding versus non-breeding), as well as geographic differences in the abundance and quality of habitat. Regardless, the central tendency of these means is about 45 percent; a somewhat higher percentage than the FWS guidelines. We retained the 40 percent threshold, however, because; 1) the FWS guidelines specify amounts of high-quality habitat, rather than a single 'suitable habitat'

category, and; 2) FWS guidelines incorporate a higher standard for classifying forest habitat as ‘suitable’ than was used in many of the studies in Figure III.C.1, and; 3).

Figure III.C.1: Proportions of older forest (see Table III.C.1) at home range scales around northern spotted owl territory centers in the Klamath Province, CA and OR. Horizontal line shows the proportion of older forest required by the Fish and Wildlife Service guidelines (40 percent).

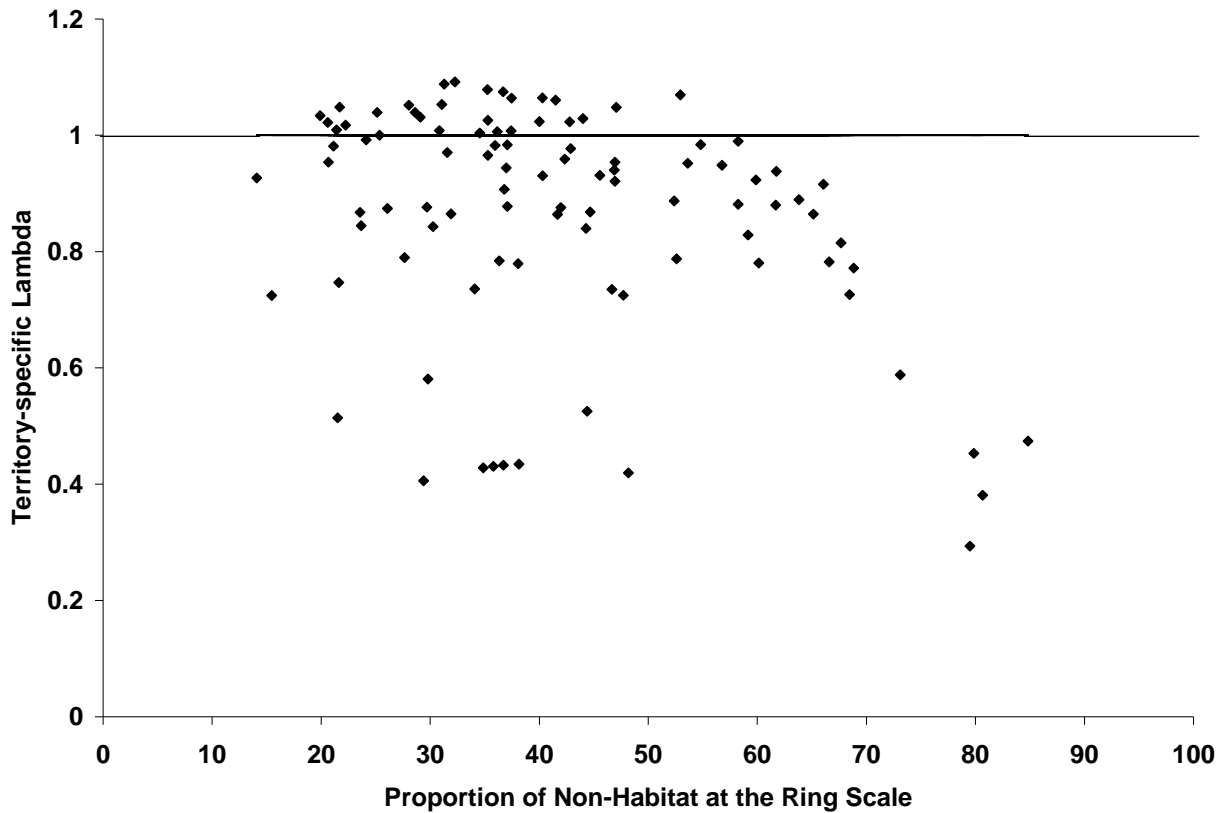


*Mean proportion. **Recommendation for take-avoidance guidelines. †Carey et al. 1992: A = Klamath Mountains, clumped forest, B = Klamath Mountains, fragmented forest, C = Umpqua, fragmented forest. ‡Zabel et al. 1993: A = Ukonom, breeding season, B = Ukonom, nonbreeding season, C = Mad River, breeding season, D = Mad River, nonbreeding season.

Research in the Klamath Province and adjacent areas indicates that NSO habitat should be concentrated at the core area scale around nests and interspersed with other land cover classes in the rest of the home range. For this reason, the FWS guidelines require retention of a higher proportion of the home range’s total suitable habitat

(particularly nesting/roosting habitat) to be within the core area, and allow a wider range of forest conditions in the outer ring. A study in southwestern Oregon showed that HFP was optimal for NSO when the estimated home range beyond the core area (3,430-acre ring) was comprised of large amounts of forest (young, mature, and old classes) and an intermediate amount (ca. 38%) of “nonhabitat” (nonforest, early seral forest, heavily harvested forest) (Dugger *et al.* 2005; see Figure III.C.2). At this scale, HFP was below 1.0 at all territories with >50 percent nonhabitat. A similar study just outside the Klamath Province in southern Oregon found that high survival of NSO usually occurred with large proportions (ca. 70 percent was optimal) of conifer forest (average DBH >9.5 inches) in estimated home ranges (1,747 acres), whereas high reproduction was associated with large amounts of edge between “nonforest” (average diameter at breast height (DBH) <9.5 inches) and other vegetation classes (Olson *et al.* 2004). These findings suggest that HFP is highest when home ranges consist of large amounts of both forest and forest-edge. Zabel *et al.* (2003) found that the best large-scale (2,224-acre) model for probability of occupancy by NSO in northwestern California was an intermediate amount of old forest (≥ 24 inches DBH and ≥ 70 percent canopy cover) edge. Thus, both the demography and presence of NSO in the Klamath Province appear to be positively associated with an intermediate amount of horizontal heterogeneity at the home range scale.

Figure III.C.2: Association between habitat fitness potential (territory-specific lambda) and proportion of “nonhabitat” (nonforest, early seral stages, older forest receiving timber harvest entries removing >40 percent basal area in the portion of the estimated home range outside the estimated core area (3,430-acre ring) in southwestern Oregon (Dugger *et al.* 2005).



Core Area (0.5-Mile Radius)

The disproportionate importance of habitat conditions within NSO core areas is indicated by the species’ concentrated use of areas close to the territory center (see *Analysis Areas and Habitat Definitions*). The core area’s relevance has also been demonstrated by strong associations between habitat patterns and the demography (Franklin *et al.* 2000, Dugger *et al.* 2005) and occurrence (Zabel *et al.* 2003) of NSO.

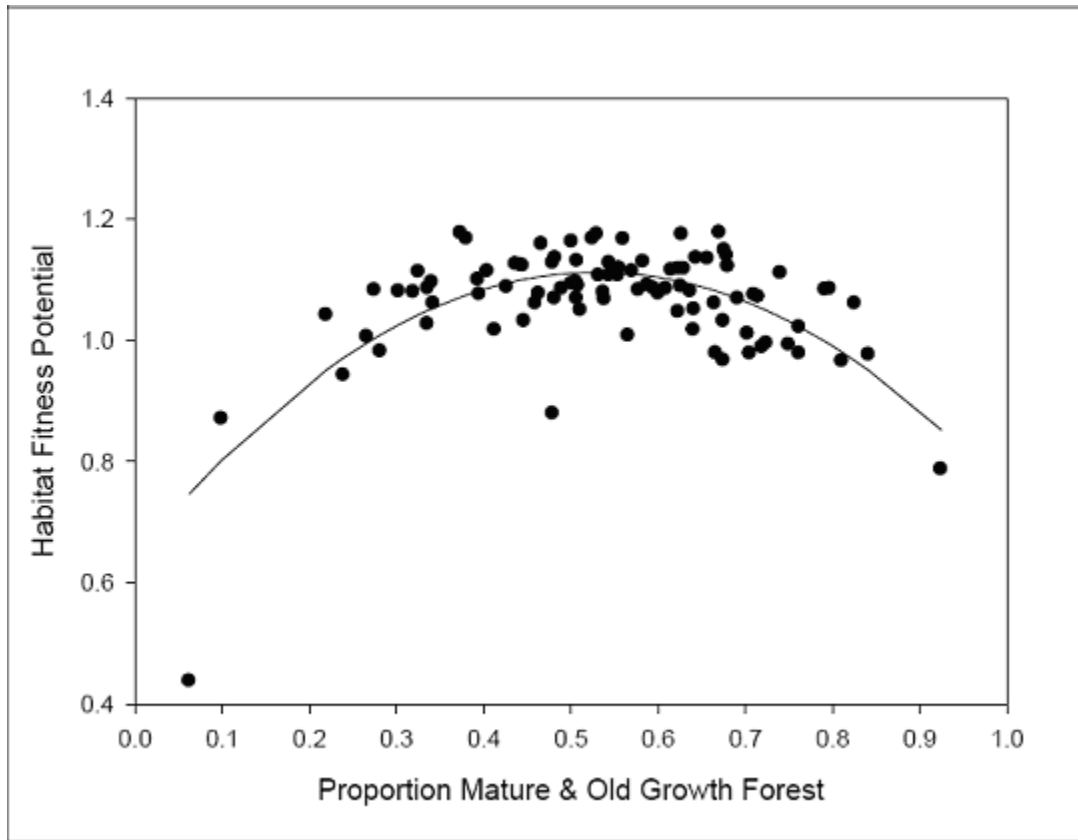
The results of two rigorous demographic studies of NSO in the Klamath Province (Franklin *et al.* 2000, Dugger *et al.* 2005) provide strong, consistent inferences regarding the relationship between habitat conditions and measures of NSO fitness such as adult survival and HFP at the core area scale. Although the habitat-based fitness models of Franklin *et al.* (2000) and Dugger *et al.* (2005) differ somewhat, both studies indicated that HFP for NSO in the Klamath Province was most likely to be ≥ 1 when at least 50% of the estimated core area was comprised of older forest (see Table III.C.1 for habitat criteria). An HFP of ≥ 1 indicates that a territory has the characteristics required for breeding females to replace themselves or contribute a surplus to the population (Franklin *et al.* 2000).

Franklin *et al.* (2000) found that territory-specific adult survival was strongly associated with the amounts of interior older forest in addition to the amount of edge between older forest and other vegetation types (see Table 7 in Franklin *et al.* 2000) at the core area scale (390 acres, 158 ha). Interior older forest was the amount of older forest 328 feet (100 m) from an edge and is not equivalent to the simple amount of older forest within a core. Interestingly, HFP declined overall when the core area contained more interior old forest. This was apparently due to a tradeoff between habitat characteristics associated with survival (amount of interior habitat and length of habitat edge) and reproduction (amount of habitat edge). High quality territories typically had core areas comprised of large patches of older forest with convoluted edges. Estimates of the amount of interior older forest that correlated with HFP > 1 were provided to the FWS by Dr. Franklin (personal communication, September 19, 2005). The minimum proportion of interior older forest corresponding to HFP > 1 was 41 percent; addition of

the older forest area within the 328-foot “edge buffer” yielded a proportion of 62 percent (“total core”: Franklin 1997). Based on this evaluation, Dr. Franklin recommended that 60 percent of the core area be comprised of older forest (Franklin, personal communication, September 19, 2005). The FWS guidelines incorporate the apparent positive influence of moderate amounts of edge by 1) requiring that retention of high-quality habitat be concentrated at the core scale and 2) specifying amounts of older forest and foraging habitat in the core.

Data sets used in Franklin *et al.* (2000) were recently re-analyzed to evaluate the relationship between HFP and the simple proportion of older forest within NSO core areas (Franklin 2006). The results of this analysis, proposed in Appendix D of the 2007 Draft Recovery Plan for the Northern Spotted Owl (USFWS 2007), indicated a quadratic relationship between HFP and older forest, with optimum HFP occurring when 53 percent of the estimated core area consisted of older forest (Franklin *et al.* 2000; Figure III.C.3). More than half (55 percent) of the high-quality (HFP ≥ 1) territories had core areas comprised of 50 to 65% older forest. This pattern is consistent with the previously described recommendations of Dr. Franklin and the habitat retention guidelines developed by the FWS.

Figure III.C.3: Relationship between habitat fitness potential for northern spotted owls and proportion of older forest (see Table III.C.1) within 0.44 mile of territory centers in northwestern California (courtesy A. Franklin)



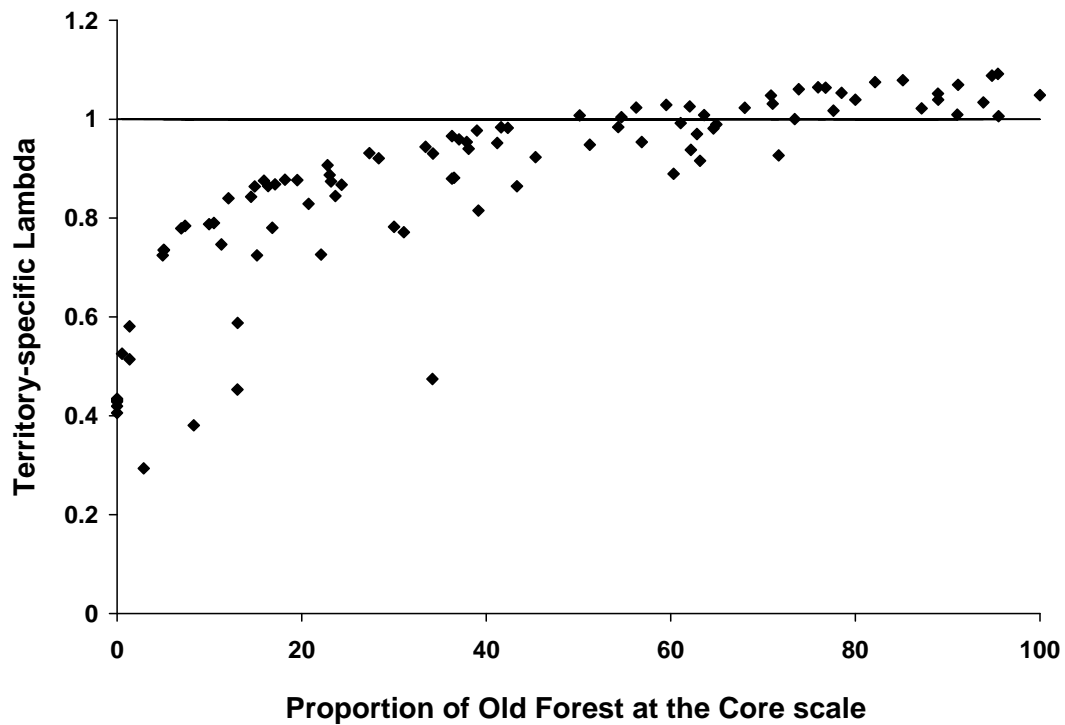
Because roughly 29 percent of high-quality territories ($HFP \geq 1$) (Figure III.C.3) contained less than 50 percent old forest, some have suggested that a substantially lower habitat retention guideline would be adequate to avoid incidental take in timber harvest operations. Use of Franklin (2006) as the sole means of support for habitat retention guidelines is inappropriate (Franklin 2007) however, because the model estimating survival based on simple amounts of older forest was not well-supported and had only 3 percent of the weight in the model set (as opposed to 42.7 percent for the best-supported model which included interior old forest and amount of edge; see Table 7 in Franklin *et*

al. 2000). Use of the simple amount of older forest for evaluating take of NSO is inappropriate because it ignores the model selection process used in Franklin *et al.* (2000), which found that simple amounts of older forest alone did not explain variation in survival nearly as well as amounts of interior older forest and edges (Franklin 2007). Nichols and Pollock (2008) reviewed the use of HFP in the draft NSO Recovery Plan and concurred with Franklin (2007), stating that plots based on a single variable (percent old forest) instead of multiple covariates in the model of Franklin *et al.* (2000) are potentially misleading. Consequently, the analysis using solely percent old forest was deleted from the final 2008 NSO Recovery Plan, and was not used by the FWS to develop recent NSO habitat retention guidelines.

In a similar study in southern Oregon, Dugger *et al.* (2005) found that HFP was positively related to the proportion of older forest in the estimated core area (413 acres, 167 ha), although it became decreasingly sensitive to increased proportions (see Figure III.C.4; Dugger, unpub. data). Roughly 72 percent of core areas with HFP greater than 1.0 had more than 50 percent older forest; whereas cores with HFP less than 1.0 never contained more than 50 percent older forest. In contrast to the conclusions of Franklin *et al.* (2000), the correlation of HFP with proportion of older forest in the estimated core area was roughly linear; HFP did not decline at high levels of older forest. It is unclear why these studies found differences in the nature of the NSOs' relationships with quantities of older forest in the core area. Possible reasons for this dissimilarity include differences in the availability and quality of habitat in the study areas and in the studies' classifications of habitat (see Table III.C.1). For example, the area studied by Dugger *et al.* (2005) was strongly fragmented by industrial timberlands in a checkerboard pattern,

whereas the area studied by Franklin *et al.* (2000) was dominated by less-intensively managed federal lands. Regardless, both studies found that high quality territories typically had core areas comprised of at least 50 percent older forest.

Figure III.C.4: Relationship between habitat fitness potential (territory-specific lambda) for northern spotted owls and proportion of older forest (see Table III.C.1) within 413 acres around territory centers in southwestern Oregon (courtesy K. Dugger)

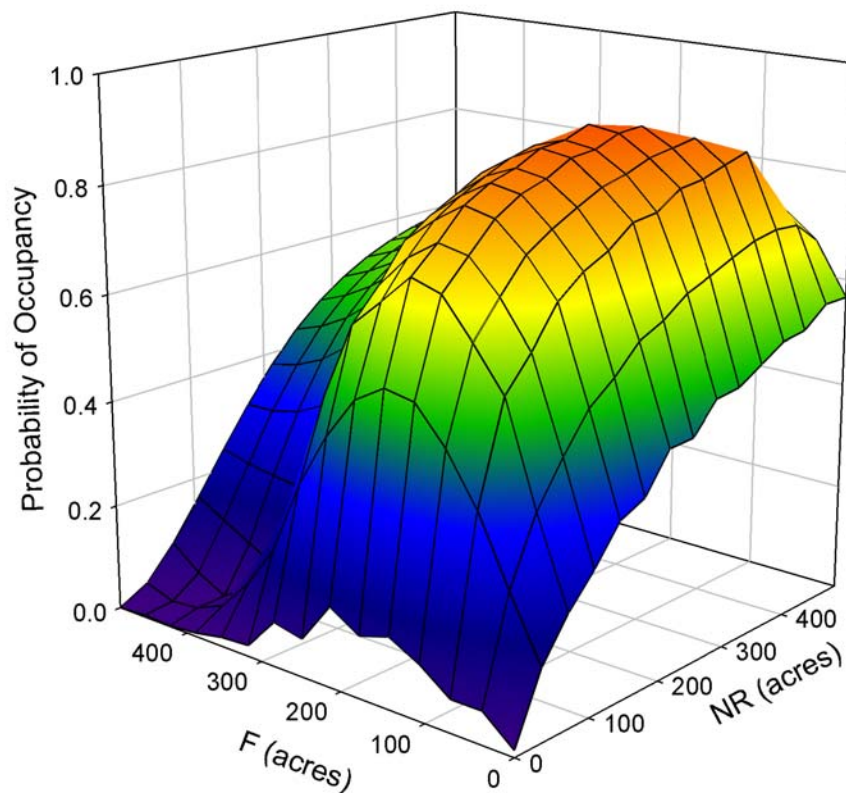


Zabel *et al.* (2003) modeled the probability of occupancy for NSO in the Klamath Province based on habitat conditions at the core area scale (500 acres). The overall best model in this study indicated that the probability of NSO occurring in a given location was positively, albeit diminishingly, influenced by increased amounts of nesting-roosting habitat and by intermediate amounts of foraging habitat at the core area scale (see Table

III.C.1 for habitat definitions). The highest probability of occupancy occurred when the core area scale consisted of 60 to 70 percent nesting-roosting habitat and 30 to 40 percent foraging habitat (see Figure III.C.5). The averages for all combinations of habitat associated with a high probability (≥ 0.70) of occupancy were 48 percent nesting-roosting habitat and 28 percent foraging habitat.

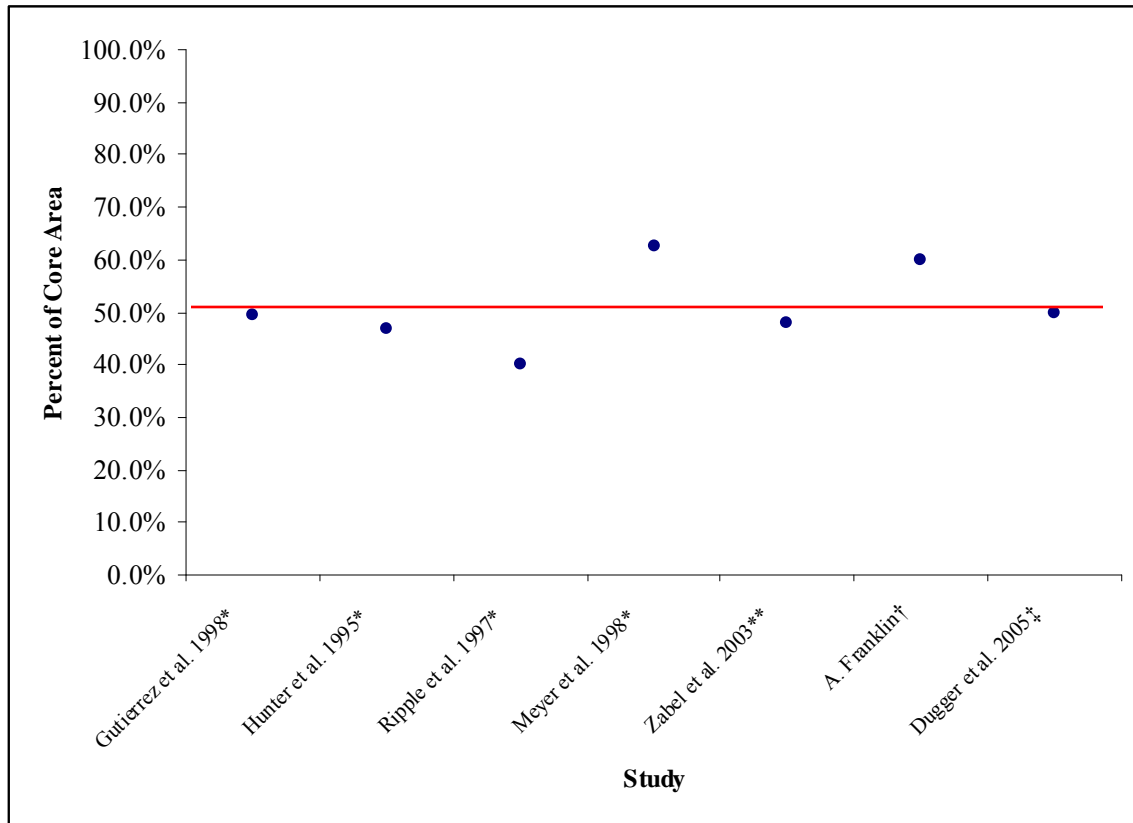
Figure III.C.5: Probability of northern spotted owl occupancy in the Klamath Province associated with amounts of nesting-roosting (NR) and foraging (F) habitats (see Table III.C.1) at the 500-acre (200 ha) scale (Zabel *et al.* 2003)

Probability of Occupancy by Quantities of NR and F habitat (acres)



Researchers have reported a wide range of mean proportions of older forest (ca. 35-60 percent; see Figure III.C.6) at the core area scale around NSO nests in the Klamath Province and adjacent areas (Hunter *et al.* 1995, Ripple *et al.* 1997, Gutiérrez *et al.* 1998, Meyer *et al.* 1998). It is difficult to assess how much of this variation was due to differences in ecological setting, spatial scale, habitat classification, and individual variation among owls. Nonetheless, the central tendency of these results was roughly 50-60 percent, which is consistent with the FWS guidelines' requirement for proportion of nesting and roosting habitat (see *Habitat Definitions*) in the core area (see Figure III.C.6). The mean proportions of older forest at core area scales were higher than those around locations chosen for comparison (random or "unused" locations). Thus, NSO in the Klamath Province appear to select home ranges with large amounts of older forest concentrated around suitable nest locations.

Figure III.C.6: Proportions of older forest (see Table III.C.1) at core area scales around northern spotted owl territory centers in the Klamath Province, CA and OR. Horizontal line shows the proportion of older forest required by the FWS guidelines (50 percent)



*Mean proportion. **Mean proportion associated with $\geq 70\%$ probability of occupancy. †Recommendation based on the combined proportions of interior and edge-buffer older forest associated with a habitat fitness potential greater than 1 (Franklin et al. 2000). ‡Approximate proportion of older forest associated with a habitat fitness potential of at least 1.

Taken together, the results of studies conducted in the Klamath Province support the conclusion that at least 50 percent of the core area should consist of older forest. Older forest is more likely than other vegetation classes to provide NSO with suitable structures for perching and nesting, a stable, moderate microclimate at nest and roost sites, and visual screening from both predators and prey (see *Habitat Definitions*).

Franklin *et al.* (2000) found that survival and HFP were highest when older forest occurred as large patches in the core area. Larger patches of forest likely buffer NSO from wind and heat associated with forest-opening edges (Chen *et al.* 1995) and predators and competitors associated with open or fragmented forest (e.g., great horned owls [*Bubo virginianus*]: Johnson 1993). Modeling by Franklin *et al.* (2000) also indicated that a balance of interior older forest and edge habitat in the core area is important to NSO in the region. The value of habitat edges for NSO might be related to the availability of woodrats and other prey species associated with more open, early-seral vegetation. The positive influence of large-bodied prey species such as woodrats on NSO reproductive success has been described in northwestern California (White 1996). However, habitat edges in the Franklin *et al.* study occurred wherever habitat was juxtaposed with other land cover classes, and was not necessarily related to the presence of woodrat habitat. In fact, the survival and reproduction of NSO did not appear to be influenced by woodrat habitat in the core area. Zabel *et al.* (2003) found that probability of occupancy by NSO was highest when the core area scale contained some foraging habitat, as well as nesting-roosting habitat. This result suggests that horizontal heterogeneity in the core area should be partially provided by a range of forest conditions suitable for use by NSO, dominated by older forest conditions, (see *Habitat Definitions*, below), not simply the juxtaposition of suitable and unsuitable habitat.

III.D: Habitat Definitions:

Determination of the amount of suitable habitat that must be retained in order to avoid incidental take of NSO is strongly influenced by the range of forest conditions that

are classified as suitable habitat. The HFP models of Franklin *et al.* (2000), Olson *et al.* (2004), and Dugger *et al.* (2005) contain a limited number of habitat variables and relatively coarse definitions of NSO habitat, and therefore must be supplemented with additional information on forest structural parameters that support classification of forest habitat as suitable for nesting and foraging. Description of the structural characteristics of NSO habitat and delineation of the range of habitat conditions corresponding to essential activities such as nesting, roosting, and foraging is a critical element of developing guidelines for evaluating the likelihood of incidental take. Because the structural attributes of habitat immediately surrounding nests are easily quantified, data supporting classification of nesting habitat are readily available (see section III.C).

Foraging habitat, on the other hand, is more variable and spatially extensive, requiring intensive radio-telemetry studies to measure use of various habitat conditions by NSO. In recent studies by the National Council for Air and Stream Improvement (NCASI), correlations between habitat data from detailed forest inventories and nocturnal locations of radio-tagged NSO and California spotted owls were used to estimate resource selection function (RSF) models (Irwin *et al.* 2007a,b) that quantify complex relationships between the owls and their environment. These models allow evaluation of the relative use of specific forest structural variables such as tree size class distribution and stand density by foraging NSO. The studies of Irwin *et al.* (2007a, b), combined with other telemetry studies (Solis and Gutiérrez 1990), provide the basis of our definitions of suitable foraging habitat for NSO.

NSO are generally associated with structurally complex conifer or mixed-conifer forests containing dense, multilayered canopies and significant components of large-

diameter trees and decadence in the form of deformed trees, snags, and down wood (Thomas *et al.* 1990, Gutiérrez 1996, Courtney *et al.* 2004, USFWS 2008). Variation in seral stage association has been reported for individuals within study areas and for populations in different study areas (Gutiérrez 1996). However, extensive use of younger forests by spotted owls tends to be reported in unusually productive forest types in coastal areas (Folliard *et al.* 1993, Thome *et al.* 1999) or in stands containing structural complexity retained from previous stands (Blakesley *et al.* 1992, Zabel *et al.* 1993, Carey and Peeler 1995, Irwin *et al.* 2000). In particular, NSO have been shown to nest and forage successfully in young redwood forests; in such areas their densities are among the highest on record (Diller and Thome 1999). Young redwood forests have also been associated with high reproduction in spotted owls (Thome *et al.* 1999). The ability of NSO to successfully occupy young redwood forests has been attributed to resource availability; young forests have been found to produce the highest abundance of woodrats in Douglas-fir/tanoak forests (Sakai and Noon 1993), and in the redwood/Douglas-fir zone, woodrats were most abundant in stands 5 to 20 years of age (Hamm *et al.* 2007: USDA Forest Service Gen. Tech. Rep. PSW-GTR-194). Ward *et al.* (1998) described the benefit of an energy rich woodrat diet; and White (1996) describes the positive influence of woodrat consumption on nesting success. The value of younger forest to NSO in the drier portions of the Klamath Province is poorly understood, whereas numerous studies in the Klamath Province and adjacent regions have demonstrated that NSO selectively use older, denser forest at a variety of spatial scales (e.g., Solis and Gutiérrez 1990, Bart and Forsman 1992, Blakesley *et al.* 1992, Carey *et al.* 1992, Hunter *et al.* 1995, Ripple *et al.* 1997, LaHaye and Gutiérrez 1999, Zabel *et al.* 2003) and that such forest is positively

associated with measures of reproduction and survival (e.g., Ripple *et al.* 1997, Meyer *et al.* 1998, Franklin *et al.* 2000, Olson *et al.* 2004, Dugger *et al.* 2005).

Although spotted owls are generally associated with and preferentially select older, denser forest, suitable habitat for the species can be viewed as a continuum of structural conditions. Owls tend to use parts of this continuum more frequently than others, and to focus their activities within certain parts of it for meeting particular life history needs. The FWS has classified this continuum into habitat categories based on the conditions' primary function and apparent quality for NSO (nesting/roosting or foraging habitat, high or low quality habitat; see Table III.D.1 and Figure III.D.1). The FWS recognizes that conditions within a habitat category may be used by NSO to meet multiple life history needs; for example, NSO may forage in nesting/roosting habitat or roost in foraging habitat. We also acknowledge that rigorous classification of habitat quality requires an understanding of the relationships between habitat conditions and the demography of NSO. However, because NSO are mobile animals with large home ranges, most studies have used low-resolution vegetation data and broad habitat categories to explore their habitat relationships (see Table III.C.1). These studies have greatly improved our understanding of NSO-habitat relationships but provide limited insight into the specific structural conditions used by owls.

Table III.D.1: Values for selected structural parameters used in the Fish and Wildlife Service guidelines to classify nesting/roosting and foraging habitat for northern spotted owls.

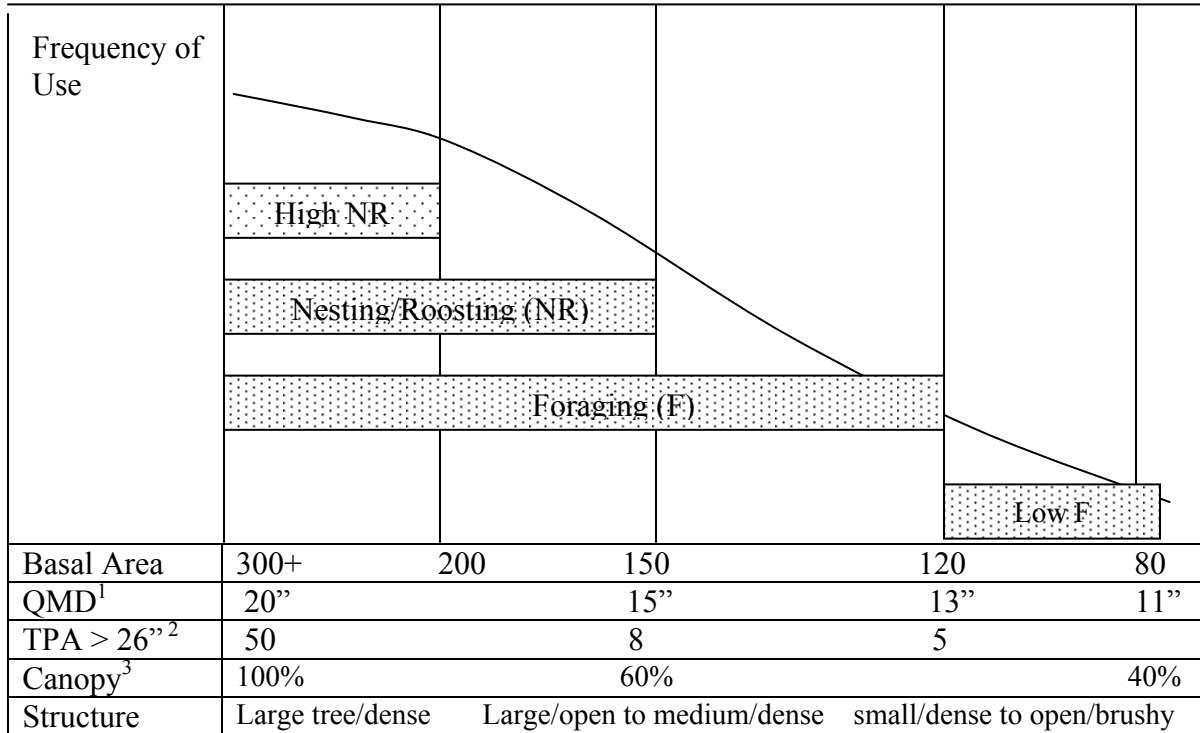
Habitat category	Tree Size (QMD) ¹	Basal Area ²	Trees > 26" dbh	Canopy closure
High nesting/roosting	≥ 15"	≥ 210 ft ²	8 per acre	≥60%
Nesting/roosting	≥ 15"	150–180+ ft ²	8 per acre	≥ 60%
Foraging	≥ 13"	120-180+ ft ²	5 per acre	≥ 60%
Low foraging	≥ 11"	80-120+ ft ²		≥ 40%

1: Quadratic Mean Diameter (inches) of trees > 5" diameter

2: Square feet per acre, trees > 5"

A few studies have provided plot-level descriptions of areas used by NSO. Habitat definitions in the FWS guidelines are primarily based on the statistical distributions of habitat parameters correlated with use by owls in these studies. Yet, the average conditions in small study plots around owl locations may poorly represent the inherent variability of stands and landscapes in owl territories. Therefore, the FWS guidelines distribute habitat categories in terms of ranges of values within analysis areas, rather than as stand averages. This approach ensures that a range of suitable habitat conditions is well-distributed at appropriate spatial scales, without being unrealistically or unreasonably prescriptive.

Figure III.D.1: Conceptual model of northern spotted owl habitat functions and associated forest structural conditions.



1: QMD= quadratic mean diameter of trees > 5 inches dbh

2: TPA>26"= trees per acres of trees >26 inches dbh

3: Canopy= percent cover of overstory trees

The FWS guidelines use a suite of structural metrics to classify NSO habitat (basal area, quadratic mean diameter, large-diameter [>26 inches DBH] trees per acre, and canopy cover) (Table III.D.1). We chose these metrics because they describe different aspects of stand structure that appear to be important to NSO and because they are commonly used by silviculturists to evaluate forest conditions. The FWS discourages the use of broad vegetation classification categories for defining habitat for NSO in the Klamath Province. These classification schemes are inappropriate for defining habitat in take-avoidance guidelines because they encompass broad ranges of vegetation parameters that often do not correspond to habitat used by NSO. For example, habitat class 4M in the CWHR system (average DBH 11 - 24 inches and average canopy cover 40-59 percent)

might describe anything from infrequently-used foraging habitat to nesting and roosting habitat. Furthermore, use of broad habitat classification schemes can mask the effects of habitat modification. For example, timber harvests could remove important habitat elements (e.g., snags, deformed trees, dense groups of large trees) while maintaining the minimum average canopy cover and tree diameter values in a given habitat category and masking the loss of habitat quantity and quality.

Habitats Used for Nesting and Roosting

The 2008 NSO Recovery Plan (USFWS 2008:50) stated that: “Features that support nesting and roosting typically include a moderate to high canopy closure (60 to 90 percent); a multi-layered, multi-species canopy with large overstory trees (with diameter at breast height [dbh] of greater than 30 inches); a high incidence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decadence); large snags; large accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for spotted owls to fly.” The validity of applying this rangewide habitat definition to the Klamath Province has been supported by numerous studies in and adjacent to the region (e.g., Solis and Gutiérrez 1990, Blakesley *et al.* 1992, Carey *et al.* 1992, Hershey *et al.* 1998, LaHaye and Gutiérrez 1999), including on private timberlands (Self *et al.* 1991, SPI 1992, Farber and Crans 2000).

The characteristic structure of nesting/roosting habitat probably serves a variety of functions for NSO. NSO may partly favor older, more decadent forest for nesting because it frequently contains suitable nest structures. Nests are usually located in older, larger-

diameter, deformed, decadent, or diseased trees containing cavities or platforms (Forsman *et al.* 1984, Hershey *et al.* 1998, LaHaye and Gutiérrez 1999, North *et al.* 2000). Northern spotted owls may also nest and roost in older, denser forest because it tends to provide a more moderate, stable microclimate compared with other kinds of forest. NSO are less able to dissipate body heat than other owls and appear to compensate by nesting and roosting in relatively cool, humid sites (Barrows 1981, Ganey *et al.* 1993, Ting 1998, Weathers *et al.* 2001). NSO also appear to use dense, multilayered canopies for protection from cold, wet weather (Forsman *et al.* 1984, North *et al.* 2000). Northern spotted owls may also prefer nesting and roosting in denser forest because it provides visual screening from predators (Carey 1985, Buchanan *et al.* 1995).

High-quality nesting/roosting habitat

As defined by the FWS guidelines, high-quality nesting/roosting habitat occurs where structural conditions resemble or exceed those of most observed NSO nest sites in northern California (see Table III.D.2). To date, no Klamath Province study has directly compared plot-level vegetation data for nest and roost sites to the demography of NSO, so it is unknown if the average structural conditions used by owls in the region are associated with high reproduction and survival. Therefore, a definition of high-quality nesting/roosting habitat must account for variability in habitat-use patterns among individuals by ensuring that the range of habitat values associated with owl use are well-represented, rather than prescribing a single criterion based on mean values.

Nesting/roosting habitat

The FWS' definition of nesting/roosting habitat is similar to high-quality nesting/roosting habitat, but is intended to reflect both variability in the structure of sites used by nesting and roosting owls and the variability typical of forest stands or patches encompassing denser nest and roost sites (see Table III.D.1 and III.D.2). The FWS guidelines' requirement for a mix of basal areas in nesting/roosting habitat allows land managers some operational flexibility but also discourages homogenization of stands during harvesting. Although it is more stringent than that used in the FPR guidelines, the FWS guidelines provide definitions of habitats used for nesting and roosting that consistent with the range of conditions found at many spotted owl nest cores on private timberlands.

Table III.D.2: Mean structural characteristics of areas used by spotted owls for nesting, roosting, and foraging (rounded to the nearest whole number). The habitat variables are basal area (BA), quadratic mean diameter (QMD), large trees per acre (TPA), and canopy cover (CC)

Source Location	FWS Guidelines Klamath Province	White 1996 Klamath National Forest*	Self et al.** Klamath Province and So. Cascades	Farber and Crans 2000 Klamath Province and So. Cascades	Irwin et al. 2007 Northern Sierra Nevada (CSOs)	L. Irwin, unpubl. Medford, Klamath Province
Habitat Type Plot Size BA (ft²/ac) QMD (in) TPA >26" TPA >35" CC%	<u>High-Quality Nesting/ Roosting</u> - ≥210 ≥15 ≥8 - ≥60	<u>Nest & Roost Sites</u> 0.2-0.3 ac 246† 8 73	<u>Nest Sites</u> 1 ac 212‡ 16‡	<u>Nest Sites</u> 0.1 ac, 2.5 ac 210, 166† 14, 12† 70, 67	<u>Roost Sites</u> 216† 16† 8 75	
Habitat Type BA (ft²/ac) QMD (in) TPA >22" TPA >26" TPA >32" CC%	<u>Nesting/ Roosting (High-Quality Foraging)</u> mix >150 ≥15 - ≥8 - ≥60		<u>Nest Patches</u> 173‡ 16 4	<u>Nest Stands</u> 124† 13†	<u>Foraging Locations</u> 190 14 7 69	<u>Foraging Locations</u> 180† 20† 8
Habitat Type BA (ft²/ac) QMD (in) TPA >26" CC%	<u>Foraging</u> mix >120 ≥13 ≥5 mix ≥40					<u>Foraging Locations (Lower 25%)</u> 120 14 0
Habitat Type BA (ft²/ac) QMD (in) CC%	<u>Low-Quality Foraging</u> mix >80 ≥11 ≥40					<u>Foraging Locations (Lower Values)</u> See Figure III.D.2 See Figure III.D.3

*Excludes data from the Goosenest Ranger District in the southern Cascade Range. **SPI = Self *et al.* 1991, SPI 1992, and Table III.D.2. †All trees >5" DBH (lower cutoff reported for QMD, assumed for BA). ‡All trees >6" DBH (lower cutoff reported for QMD, assumed for BA).

Foraging Habitat

Foraging habitat encompasses nesting and roosting habitat but includes a broader range of structure and might not support successful nesting by NSO (Gutiérrez 1996, USFWS 2008). Foraging NSO generally use older, denser, and more complex forest than expected based on its availability, but they also use younger forest (Solis and Gutiérrez 1990, Carey *et al.* 1992, Zabel *et al.* 1993, Carey and Peeler 1995, Anthony and Wagner 1999, Irwin *et al.* 2007b). The FWS guidelines incorporate this structural variability by specifying retention of habitat in four functional categories of habitat suitable for NSO. High-quality nesting/roosting and nesting/roosting habitat provide the upper range of stand structure selected by foraging NSO; foraging habitat encompasses a broad range of structure, and low-quality foraging habitat includes younger and more open habitats that may be important for prey production (Tables III.D.1 and III.D.2; Figure III.D.1). Northern spotted owls may prefer older, denser forest for foraging because it often contains both abundant prey and suitable structural characteristics for hunting. Several important prey species, including flying squirrels (*Glaucomys sabrinus*) and western red-backed voles (*Clethrionomys californicus*) tend to be most abundant in older, denser forest (Carey *et al.* 1992; Waters and Zabel 1995, 1998). Other important prey species, such as woodrats, have been found to be most abundant in young sapling stands (Sakai and Noon 1993), but can also reach high abundances in dense, old forest (Carey *et al.* 1992, Sakai and Noon 1993). Spotted owls usually hunt by listening and scanning for prey from elevated perches (Forsman *et al.* 1984). Dense, multilayered forest might provide owls with hunting perches at a variety of canopy levels (North *et al.* 1999). Dense vegetation might also visually screen foraging NSO from predators and prey

(Carey 1985, Buchanan *et al.* 1995). Conversely, spotted owls require space for flying, which could place an upper limit on the understory density of suitable habitat (Irwin *et al.* 2007b).

Descriptions of habitat structure used by foraging NSO are typically based on studies employing radio telemetry to monitor owl movements. While the habitats associated with nocturnal telemetry locations are commonly termed ‘foraging locations’, some researchers point out that the owl locations simply indicate the distribution of movements, and may not correspond to sites and habitats actually used by actively foraging NSO. During radio telemetry studies in northwestern California, Diller (unpub. data), found that owls moved frequently during monitoring periods (7.5 minutes/perch for 6 males; 17.0 minutes/perch for 4 females), suggesting that the process of triangulating azimuths for each location was unlikely to detect a specific site used for foraging. Conversely, owls in this study also were stationary for long periods of time, possibly resting, preening, or other activities not associated with active foraging. For these reasons, the FWS recognizes that our descriptions of NSO foraging habitat likely represent the range of habitat conditions used by owls at night, and may not represent the specific habitat qualities of sites where NSO successfully obtain prey.

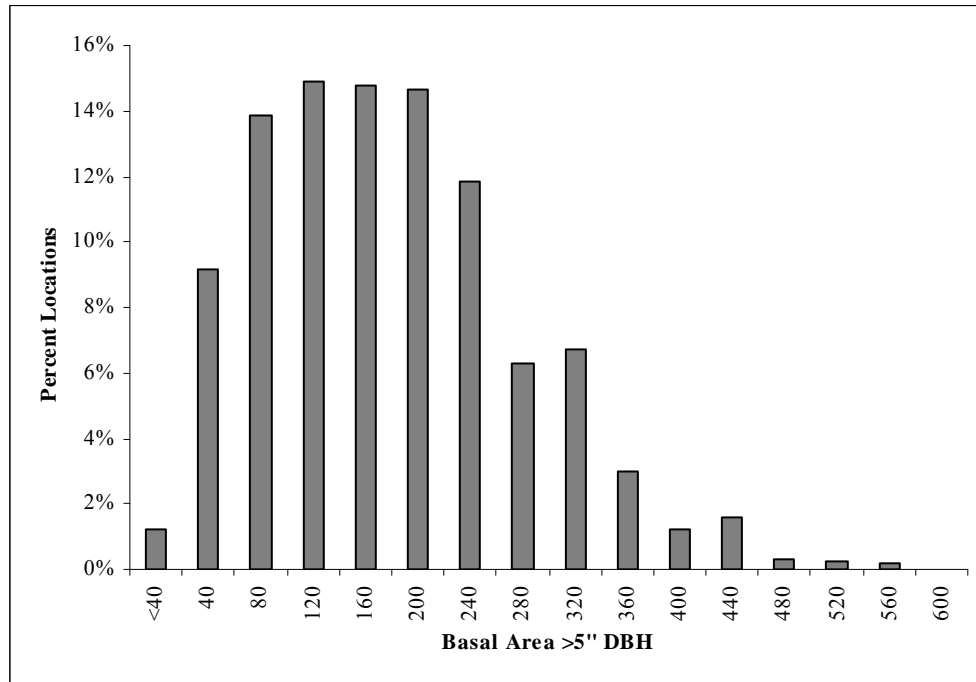
There are currently no published plot-based descriptions of NSO foraging habitat in the Klamath Province. We therefore strongly considered the results of both unpublished studies of NSO and a published study of California spotted owls (*Strix occidentalis occidentalis*, CSOs) in the northern Sierra Nevada (Irwin *et al.* 2007b) while formulating these habitat definitions. Much of the CSO study was conducted in a mixed-conifer/hardwood forest similar to forest types used by NSO in the Klamath Province.

Although spotted owls often selectively foraged in older forest, these telemetry studies show that they also use a relatively wide range of forest structure (Irwin *et al.* 2004, 2007).

The range of forest structure specified in the FWS guidelines is also based on the distribution of habitat use by foraging NSO in the Klamath Province. Analysis of radio-telemetry data from NSO in southern Oregon (L. Irwin, unpublished data) indicates that roughly 46 percent of nocturnal (foraging) locations occurred in nesting/roosting habitat (basal area ≥ 210 ft²/acre), and 76 percent occurred in stands classified as foraging, nesting, and roosting habitat (Figure III.D.2). Only 14% of locations were in stands classified as low-quality foraging habitat. Thus, the functional habitat categories specified in the FWS guidelines capture about 90 percent of the observed distribution of actual use by NSO, but also require retention of the full range of structural conditions corresponding to nesting, roosting, and foraging.

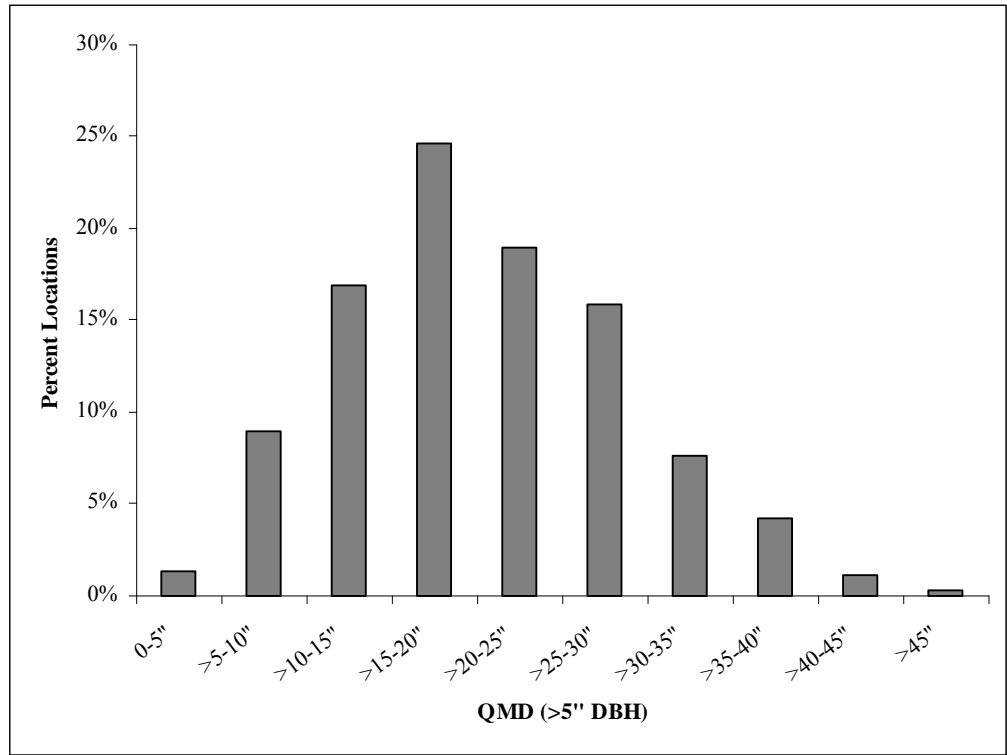
In addition to the structural characteristics addressed in the FWS guidelines, studies have indicated that certain conifer species such as Douglas-fir, as well as hardwoods and dead woody materials are important features of spotted owl foraging habitat (North *et al.* 1999, Irwin *et al.* 2000, Glenn *et al.* 2004, Irwin *et al.* 2007).

Figure III.D.2: Distribution of basal area at inventory plots near nocturnal telemetry locations for northern spotted owls in the Medford area of the Klamath Province (L. Irwin, unpublished data). This figure shows some of the range of basal area values used for foraging; it does not show selection or avoidance of particular values since available conditions were not described.



DBH: diameter at breast height, in inches

Figure III.D.3: Distribution of quadratic mean diameter (QMD) at inventory plots near nocturnal telemetry locations for northern spotted owls in the Medford area of the Klamath Province (L. Irwin, unpublished data). This figure shows some of the range of QMD values used for foraging; it does not show selection or avoidance of particular values since available conditions were not described.



DBH: diameter at breast height, in inches

Abiotic Habitat Characteristics

Habitat selection by breeding NSO is strongly influenced by spatial and topographic features such as proximity to nest, distance to water, slope position, and elevation.

Termed ‘abiotic considerations’ in the FWS guidelines, these factors act to influence the habitat value of forest stands, and subsequently the importance of retaining habitat based on landscape position as well as stand structure. Abiotic considerations are explicitly incorporated into the FWS guidelines through a prioritization system that ranks habitat retention areas based on distance to nest, contiguity, slope position, aspect, and elevation.

Because the guidelines for abiotic considerations are less prescriptive than the guidelines for stand structure, they are more easily applied during habitat evaluations on a case by case basis.

Habitat selection by breeding NSO is strongly associated with proximity to the nest, as well as with vegetation characteristics (Carey and Peeler 1995, Rosenberg and McKelvey 1999, Glenn *et al.* 2004, Irwin *et al.* 2007b). Spotted owls appear to be central-place foragers, disproportionately using areas near the nest in order to minimize travel costs and maximize their energetic return from foraging (Carey and Peeler 1995, Rosenberg and McKelvey 1999). Home range studies have also indicated the importance of the territory center to spotted owls (see *Analysis Areas*). Combined, spatial patterns of habitat selection and habitat use suggest that NSO may be more sensitive to reductions of habitat in their core areas than in other parts of their home ranges. The FWS guidelines therefore emphasize retention of habitat at the core area scale.

Topography also appears to influence habitat use by NSO; which use lower slope positions more frequently than higher ones (Forsman *et al.* 1984, Blakesley *et al.* 1992, Hershey *et al.* 1998, LaHaye and Gutiérrez 1999, Irwin *et al.* 2007b). Lower slopes likely provide cooler, more humid microclimates for nesting and roosting and favor growth of the denser forest structure preferred by spotted owls. Furthermore, lower slope positions tend to have less frequent and severe fire regimes, potentially allowing trees to attain greater density, sizes and ages than on higher slopes (Beaty and Taylor 2001, Skinner *et al.* 2006). Spotted owls also appear to prefer areas close to streams, which often occur at the bottoms of slopes (Solis and Gutiérrez 1990, LaHaye and Gutiérrez 1999, Irwin *et al.* 2007b). Areas near streams likely tend to be more productive and have cooler, more

humid microclimates than upland areas. Additionally, prey abundance can be high in riparian areas (Carey *et al.* 1992, Anthony *et al.* 2003) and NSO may use streams for drinking and bathing (Forsman *et al.* 1984). Some studies have found that NSO in the Klamath Province selectively use northerly aspects, but others found different patterns or no pattern at all (Solis and Gutiérrez 1990, Blakesley *et al.* 1992, Carey *et al.* 1992, Zabel *et al.* 1993, Farber and Crans 2000). Suitable microclimates for nesting and roosting, and for the vegetation structure preferred by NSO, may occur more frequently on north-facing slopes than on other aspects. However, aspect does not appear to influence vegetation distribution as strongly in some areas as in others (e.g., Zabel *et al.* 1993). Elevation also seems to influence habitat-use by spotted owls (Solis and Gutiérrez 1990, Blakesley *et al.* 1992, Hershey *et al.* 1998, LaHaye and Gutiérrez 1999, Irwin *et al.* 2007b). This might be related both to spotted owls' disproportionate use of lower slope positions and to the influence of elevation on vegetation distribution. The productive vegetation types favored by NSO, such as mixed-evergreen forest, primarily occur at lower elevations in the Klamath Province (Sawyer 2007).

III. E. Conclusions:

The FWS has conducted a thorough review and synthesis of published literature, unpublished data sets, and direct communication with NSO researchers in support of a rigorous process for evaluating the effects of habitat management on NSO. It is important to recognize that the habitat conditions described in the document are intended for use in estimating the likelihood of take of individual NSO under the ESA; they do not represent habitat conditions required for population growth or recovery. The FWS

guidelines focus solely on individual NSO territories and do not incorporate larger-scale issues such as connectivity and dispersal habitat, wintering habitat, or longer-term habitat disturbance patterns. The FWS habitat evaluation guidelines that this science review document supports are complex; reflecting the complex nature of forest environments in the Klamath Province and the forest products industry's requirement to retain maximum flexibility to conduct timber harvests in the vicinity of occupied NSO territories.

Literature Cited

- Anthony, R.G., M.A. O'Connell, M.M. Pollock, and J.G. Hallett. 2003. Associations of mammals with riparian ecosystems in Pacific Northwest forests. Pp. 510-563 *In* C.J. Zabel and R.G. Anthony (eds.), *Mammal community dynamics: Management and conservation in the coniferous forests of western North America*. Cambridge University Press, New York.
- Anthony, R.G. and F.F. Wagner. 1999. Reanalysis of northern spotted owl habitat use on the Miller Mountain Study Area. Unpublished report. Submitted to Bureau of Land Management, Medford District and Forest and Rangeland Ecosystem Science Center, Biological Resources Division, U.S. Geological Survey.
- Barrows, C.W. 1981. Roost selection by spotted owls: an adaptation to heat stress. *Condor* 83:302-309.
- Bart, J. 1992. Comments on the guidelines for avoiding take. Comment provided to the Northern Spotted Owl Recovery Team, March 29, 1992.
- Bart, J. 1995. Amount of suitable habitat and viability of northern spotted owls. *Conservation Biology* 9(4):943-946.
- Bart, J. and E.D. Forsman. 1992. Dependence of northern spotted owls *Strix occidentalis caurina* on old-growth forests in the western USA. *Biological Conservation* 62:95-100.
- Beaty, R.M. and A.H. Taylor. 2001. Spatial and temporal variation in fire regimes and forest dynamics in a mixed conifer forest landscape, southern Cascades, California. *Journal of Biogeography* 28:955-966.
- Bingham, B.B. and B.R. Noon. 1997. Mitigation of habitat "take": application to habitat

- conservation planning. *Conservation Biology* 11(1):127-139.
- Blakesley, J.A., A.B. Franklin, and R.J. Gutiérrez. 1992. Spotted owl roost and nest site selection in northwestern California. *Journal of Wildlife Management* 56(2):388-392.
- Börger, L., N. Franconi, G. de Michele, A. Gantz, F. Meschi, A. Manica, S. Lovari, and T. Coulson. 2006. Effects of sampling regime on the mean and variance of home range size estimates. *Journal of Animal Ecology* 75:1393-1405.
- Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1995. Within-stand nest site selection by spotted owls in the eastern Washington Cascades. *Journal of Wildlife Management* 59(2):301-310.
- Burt, W.H. 1943. Territoriality and home range concepts as applied to mammals. *Journal of Mammalogy* 24:346-352.
- CALFIRE (California Department of Forestry and Fire Protection). 2008. Important information for timber operations proposed within the range of the northern spotted owl. Department of Forestry and Fire Protection, Sacramento, CA.
- Carey, A.B. 1985. A summary of the scientific basis for spotted owl management. Pp. 100-114 *In* R.J. Gutiérrez and A.B. Carey (tech. eds.), *Ecology and management of the spotted owl in the Pacific Northwest*, Arcata, California, June 19-23, 1984. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, General Technical Report PNW-185.
- Carey, A.B., S.P. Horton, and B.L. Biswell. 1992. Northern spotted owls: influence of prey base and landscape character. *Ecological Monographs* 62(2):223-250.
- Carey, A.B. and K.C. Peeler. 1995. Spotted owls: resource and space use in mosaic

- landscapes. *Journal of Raptor Research* 29(4):223-239.
- Carey, A.B., J.A. Reid, and S.P. Horton. 1990. Spotted owl home range and habitat use in southern Oregon Coast Ranges. *Journal of Wildlife Management* 54(1):11-17.
- Carroll and Johnson 2008
- Chen, J., J.F. Franklin, and T.A. Spies. 1995. Growing-season microclimatic gradients from clearcut edges into old-growth Douglas-fir forests. *Ecological Applications* 5(1):74-86.
- Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, and L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute, Portland, OR.
- Dugger, K.M., F. Wagner, R.G. Anthony, and G.S. Olson. 2005. The relationship between habitat characteristics and demographic performance of northern spotted owls in southern Oregon. *The Condor* 107:863-878.
- Farber, S. and R. Crans. 2000. Habitat relationships of northern spotted owls (*Strix occidentalis caurina*) on Timber Products forestlands in northern California. Unpublished report. Prepared for: the U.S. Fish and Wildlife Service for their review of management activities conducted in compliance with the spotted owl management plan.
- Folliard, L.B., L.V. Diller, and K.P. Reese. 1993. Occurrence and nesting habitat of

- northern spotted owls in managed young-growth forests in northwestern California. *Journal of Raptor Research* 27(1):69.
- Forsman, E.D., R.G. Anthony, E.C. Meslow, and C.J. Zabel. 2004. Diets and foraging behavior of northern spotted owls in Oregon. *Journal of Raptor Research* 38(3):214-230.
- Forsman, E.D., E.C. Meslow, and H.M. Wright. 1984. Distribution and biology of the spotted owl in Oregon. *Wildlife Monographs* 87:1-64.
- Franklin, A.B. 1997. Factors affecting temporal and spatial variation in northern spotted owl populations in northwest California. Ph.D. Dissertation, Colorado State University, Fort Collins, CO. 185 pp.
- Franklin, A.B., D.R. Anderson, R.J. Gutiérrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. *Ecological Monographs* 70(4):539-590.
- Franklin, A. B. 2005. Notes from meeting with Dr. Alan Franklin, Colorado State University, in Salyer, California, (September 19, 2005).
- Franklin, A. B. 2006. Analysis of relationship between territory-specific lambda and amounts of mature forest habitat. Letter dated September 20, 2006 to the Northern Spotted Owl Recovery Team.
- Franklin, A. B. 2007. Comments on the Draft Recovery Plan for the Northern spotted Owl. Letter dated June 25, 2007, to Dr. Paul Phifer, Project Manager, Northern Spotted Owl Recovery Plan.
- Ganey, J.L., R.P. Balda, and R.M. King. 1993. Metabolic rate and evaporative water loss of Mexican spotted and great horned owls. *Wilson Bulletin* 105(4):645-656.

- Glenn, E.M., M.C. Hansen, and R.G. Anthony. 2004. Spotted owl home-range and habitat use in young forests of western Oregon. *Journal of Wildlife Management* 68(1):33-50.
- Gutiérrez, R.J. 1996. Biology and distribution of the northern spotted owl. *Studies in Avian Biology* 17:2-5.
- Gutiérrez, R.J., J.E. Hunter, G. Chávez-León, and J. Price. 1998. Characteristics of spotted owl habitat in landscapes disturbed by timber harvest in northwestern California. *Journal of Raptor Research* 32(2):104-110.
- Hershey, K.T., E.C. Meslow, and F.L. Ramsey. 1998. Characteristics of forests at spotted owl nest sites in the Pacific Northwest. *Journal of Wildlife Management* 62(4):1398-1410.
- Hunter, J.E., R.J. Gutiérrez, and A.B. Franklin. 1995. Habitat configuration around spotted owl sites in northwestern California. *The Condor* 97(3):684-693.
- Irwin, L.L., D.F. Rock, and G.P. Miller. 2000. Stand structures used by northern spotted owls in managed forests. *Journal of Raptor Research* 34(3):175-186.
- Irwin, L.L., D. Rock, and S. Rock. 2002. Adaptive management monitoring of northern and California spotted owls. Annual progress report. National Council for Air and Stream Improvement, unpublished report.
- Irwin, L.L., D. Rock, and S. Rock. 2004. Adaptive management monitoring of northern and California spotted owls. Annual progress report. National Council for Air and Stream Improvement, unpublished report.
- Irwin, L.L., D. Rock, and S. Rock. 2005. Adaptive management monitoring of spotted Owls. Annual progress report. National Council for Air and Stream

- Improvement, unpublished report.
- Irwin, L.L., D. Rock, and S. Rock. 2006. Adaptive management monitoring of spotted Owls. Annual progress report. National Council for Air and Stream Improvement, unpublished report.
- Irwin, L.L., D. Rock, and S. Rock. 2007a. Adaptive management monitoring of spotted owls. Annual progress report. National Council for Air and Stream Improvement, unpublished report.
- Irwin, L.L., L.A. Clark, D.C. Rock, and S.L. Rock. 2007b. Modeling foraging habitat of California spotted owls. *Journal of Wildlife Management* 71(4):1183-1191.
- Irwin, L.L. 2009. Forest structure at nocturnal radio telemetry locations of northern spotted owls in the Medford Study Site. Unpublished data provided to U.S. Fish and Wildlife Service.
- Johnson, D.H. 1993. Spotted owls, great horned owls, and forest fragmentation in the central Oregon Cascades. M.S. thesis. Oregon State University, Corvallis.
- LaHaye, W.S. and R.J. Gutiérrez. 1999. Nest sites and nesting habitat of the northern spotted owl in northwestern California. *The Condor* 101:324-330.
- Laver, P.N. and M.J. Kelly. 2008. A critical review of home range studies. *Journal of Wildlife Management* 72(1):290-298.
- Meyer, J.S., L.L. Irwin, and M.S. Boyce. 1998. Influence of habitat abundance and fragmentation on northern spotted owls in western Oregon. *Wildlife Monographs* 139:1-51.
- North, M.P., J.F. Franklin, A.B. Carey, E.D. Forsman, and T. Hamer. 1999. Forest stand

- structure of the northern spotted owl's foraging habitat. *Forest Science* 45(4):520-527.
- North, M., G. Steger, R. Denton, G. Eberlein, T. Munton, and K. Johnson. 2000. Association of weather and nest-site structure with reproductive success in California spotted owls. *Journal of Wildlife Management* 64(3):797-807.
- Olson, G.S., E.M. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. *Journal of Wildlife Management* 68(4):1039-1053.
- Nichols, J. D. and K. H. Pollock. 2008. Review of habitat fitness potential. Pages 97—98 *In* Scientific Review of the Draft Northern Spotted Owl Recovery Plan and Reviewer Comments. Sustainable Ecosystems Institute. March 2008.
- Powell, R.A. 2000. Animal home ranges and territories and home range estimators. Pp. 65-110 *In* L. Boitani and T.K. Fuller (eds.), *Research techniques in animal ecology: controversies and consequences*. Columbia University Press, New York.
- Reynolds, R.T. and S.M. Joy. 1998. Distribution, territory occupancy, dispersal and demography of northern goshawks on the Kaibab Plateau, Arizona: final report. Heritage Project No. I94045. Arizona Game and Fish Department, Phoenix, Arizona, USA.
- Ripple, W.J., P.D. Lattin, K.T. Hershey, F.F. Wagner, and E.C. Meslow. 1997. Landscape composition and pattern around northern spotted owl nest sites in southwest Oregon. *Journal of Wildlife Management* 61(1):151-158.
- Rosenberg, D.K. and K.S. McKelvey. 1999. Estimation of habitat selection for central-

- place foraging animals. *Journal of Wildlife Management* 63(3):1028-1038.
- Sakai, H.F. and B.R. Noon. 1993. Dusky-footed woodrat abundance in different-aged forests in northwestern California. *Journal of Wildlife Management* 57(2):373-382.
- Sakai, H.F. and B.R. Noon. 1997. Between-habitat movement of dusky-footed woodrats and vulnerability to predation. *Journal of Wildlife Management* 61(2):343-350.
- Sawyer, J.O. 2007. Forests of northwestern California. Pp. 253-295 *In* M.G. Barbour, T. Keeler-Wolf, and A.A. Schoenherr (eds.), *Terrestrial vegetation of California*. University of California Press, Berkeley.
- Self, S.E. and E.C. Murphy. 1995. Five year review of northern spotted owl performance for home ranges containing either deficit or excess habitat, as defined by Sierra Pacific Industries spotted owl management plan. Unpublished report.
- Self, S.E., S. Warner, and E. Murphy. 1991. A performance based definition and description of suitable spotted owl habitat. Unpublished report.
- Skinner, C.N., A.H. Taylor, and J.K. Agee. 2006. Klamath Mountains bioregion. Pp. 170-194 *In* N.G. Sugihara, J.W. van Wagendonk, J. Fites-Kaufman, K.E. Shaffer, and A.E. Thode (eds.). *Fire in California's ecosystems*. University of California Press, Berkeley.
- Solis, D.M., Jr. and R.J. Gutiérrez. 1990. Summer habitat ecology of northern spotted owls in northwestern California. *The Condor* 92:739-748.
- SPI (Sierra Pacific Industries). 1992. Sierra Pacific Industries spotted owl management plan review of implementation and effectiveness. Unpublished report. Prepared for Sierra Pacific Industries' foresters and biologists.

- Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. A report by the Interagency Scientific Committee to address the conservation of the northern spotted owl. USDA Forest Service, and US Department of the Interior, Fish and Wildlife Service, Bureau of Land Management, and National Park Service. Portland, OR.
- Thome, DM., C.J. Zabel, and L.V. Diller. 1999. Forest stand characteristics and reproduction of northern spotted owls in managed north-coastal California forests. *Journal of Wildlife Management* 63(1):44-59.
- Ting, T.F. 1998. The thermal environment of northern spotted owls in northwestern California: possible explanations for use of interior old growth and coastal early successional stage forest. M.S. thesis. Humboldt State University, Arcata, CA.
- USFWS (U.S. Fish and Wildlife Service). 1992. Draft Recovery Plan for the Northern Spotted Owl. USDI Fish and Wildlife Service, Portland, OR.
- USFWS (U.S. Fish and Wildlife Service). 2007. Draft Recovery Plan for the Northern Spotted Owl (*Strix occidentalis caurina*). Region 1, U.S. Fish and Wildlife Service, Portland, OR.
- USFWS (U.S. Fish and Wildlife Service). 2008. Recovery plan for the northern spotted owl (*Strix occidentalis caurina*). Region 1, U.S. Fish and Wildlife Service, Portland, OR.
- Wagner, F.F. and E.C. Meslow. 1989. Spotted owl monitoring: Medford segment: Miller Mountain Study Area. Supplement number PNW 86-390 to master memorandum of understanding no. PNW 80-87.
- Ward, J.P., Jr., R.J. Gutiérrez, and B.R. Noon. 1998. Habitat selection by northern spotted

- owls: the consequences of prey selection and distribution. *The Condor* 100:79-92.
- Waters, J.R. and C.J. Zabel. 1995. Northern flying squirrel densities in fir forests of northeastern California. *Journal of Wildlife Management* 59(4):858-866.
- Waters, J.R. and C.J. Zabel. 1998. Abundances of small mammals in fir forests in northeastern California. *Journal of Mammalogy* 79(4):1244-1253.
- Weathers, W.W., P.J. Hodum, and J.A. Blakesley. 2001. Thermal ecology and ecological energetics of California spotted owls. *The Condor* 103:678-690.
- White, K. 1996. Comparison of fledging success and sizes of prey consumed by spotted owls in northwestern California. *J. Raptor Res.* 30(4):234-236.
- White, A.E. 1996. Nest-site microhabitat of the spotted owl in the Klamath National Forest, California. M.S. thesis. University of Arkansas, Little Rock, AR.
- Zabel, C.J., J.R. Dunk, H.B. Stauffer, L.M. Roberts, B.S. Mulder, and A. Wright. 2003. Northern spotted owl habitat models for research and management application in California. *Ecological Applications* 13(4):1027-1040.
- Zabel, C.J., K. McKelvey, P.W.C. Paton, B.B. Bingham, and B.R. Noon. 1993. Home range size and habitat use patterns of northern spotted owls in northwestern California and southwestern Oregon. Unpublished manuscript.
- Zabel C.J., K.S. McKelvey, and J.P. Ward, Jr. 1995. Influence of primary prey on home-range size and habitat-use patterns of northern spotted owls (*Strix occidentalis caurina*). *Canadian Journal of Zoology* 73(3):433-439.

Appendix A: Full text of U.S. Fish and Wildlife Service Guidance for Evaluation of Take for Northern Spotted Owls on Private Timberlands in California's Northern Interior Region

I. Accuracy of NSO activity center location and status

1) Location

- a. Confirm plotted activity center location accuracy
 - i. CDFG Reports 2 and 3
 - ii. Data from adjacent landowners
 - iii. Recent surveys
- b. Document deviations from CDFG locations
- c. Update habitat analysis maps as necessary

2) Status

- a. Valid site
 - i. Review page 11 of protocol to determine
 - ii. If not valid, report to CDFG for inclusion in next database update
- b. Current occupancy status
- c. Current reproductive status, if determined

II. Survey Effort

1) Coverage

- a. Surveys of nesting/roosting habitat out to 0.7 miles from THP boundary
 - i. Use THP habitat map(s) to verify

2) Protocol survey

- a. Time of day
- b. Spacing between visits
- c. Number of surveys
- d. Survey dates
- e. Time spent at each call point

3) Follow up visit(s)

- a. Confirm that the area searched covers suitable habitat within response location/last known location within a logical distance.
- b. Time of follow up and duration of follow up
- c. Additional night surveys
 - i. Review page 10 of protocol

III. Habitat

1) Typing

- a. Verify habitat typing with aerial photos, equivalent imagery, or field visits

- b. Changes to typing need to be reflected in the NSO habitat acres table and habitat analysis maps
 - c. Post harvest typing
 - i. Post-harvest habitat typing must agree with the silviculture prescription
- 2) Definitions
- a. Nesting/roosting
 - i. High Quality Nesting/roosting Habitat
 - 1. Basal Area = 210+ square feet, **and**
 - 2. $\geq 15''$ quadratic mean diameter (QMD) , **and**
 - 3. ≥ 8 trees per acre (TPA) of trees $\geq 26''$ in diameter at breast height (DBH) , **and**
 - 4. $\geq 60\%$ canopy closure
 - ii. Nesting/roosting Habitat
 - 1. A mix of basal areas ranging from 150-180+ square feet, **and**
 - 2. $\geq 15''$ QMD, **and**
 - 3. ≥ 8 TPA of trees $\geq 26''$ DBH, **and**
 - 4. $\geq 60\%$ canopy closure
 - b. Foraging
 - i. Foraging Habitat
 - 1. A mix of basal areas ranging from 120-180+ square feet, **and**
 - 2. $\geq 13''$ QMD, **and**
 - 3. ≥ 5 TPA of trees $\geq 26''$ DBH, **and**
 - 4. A mix of $\geq 40\%$ -100% canopy closure
 - ii. Low Quality Foraging Habitat
 - 1. A mix of basal areas ranging from 80-120+ square feet, **and**
 - 2. $\geq 11''$ QMD, **and**
 - 3. $\geq 40\%$ canopy closure
- 3) Quantities
- a. Within 1000 feet of activity center
 - i. Outside breeding season (September 1 through January 31): no timber operations other than use of existing roads
 - ii. During the breeding season (February 1 through August 31): no timber operations other than the use of existing, permanent, year-round roads
 - b. Within 0.5 mile radius (502 acres) centered on activity center
 - i. Retention of habitat should follow Section III. 4 of this document
 - ii. At least 250 acres nesting/roosting habitat present, as follows:
 - 1. 100 acres High Quality Nesting/roosting Habitat, **and**
 - 2. 150 acres Nesting/roosting Habitat
 - AND-
 - iii. At least 150 acres foraging habitat must be present, as follows:
 - 1. 100 acres Foraging Habitat, **and**
 - 2. 50 acres Low Quality Foraging Habitat
 - iv. No more than 1/3 of the remaining suitable habitat may be harvested during the life of the THP

- c. Between 0.5 mile radius and 1.3 miles radius circles centered on activity center
 - i. Retention of habitat should follow Section III. 4 of this document
 - ii. ≥ 935 acres suitable habitat must be present, as follows:
 - 1. At least 655 acres Foraging Habitat, **and**
 - 2. At least 280 acres Low Quality Foraging, **and**
 - 3. No more than 1/3 of the remaining suitable habitat may be harvested during the life of the THP
- 4) Priority Ranking of Habitat Retention Acres
- a. Tree species composition
 - i. Mixed conifer stands should be selected over pine dominated stands
 - b. Abiotic considerations
 - i. Distance to nest
 - 1. Nesting/roosting and foraging habitat closest to identified nest trees, or roosting trees if no nest trees identified
 - ii. Contiguous
 - 1. Nesting/roosting habitat within the 0.5 mile radius must be as contiguous as possible
 - 2. Minimize fragmentation of foraging habitat as much as possible
 - iii. Slope position
 - 1. Habitats located on the lower 1/3 of slopes provide optimal micro-climate conditions and an increased potential for intermittent or year-round water sources
 - iv. Aspect
 - 1. Habitats located on northerly aspects provide optimal vegetation composition and cooler site conditions
 - v. Elevation
 - 1. Habitat should be at elevations of less than 6000 feet, though the elevation of some activity centers (primarily east of Interstate 5) may necessitate inclusion of habitat at elevations greater than 6000 feet.

IV. Determination

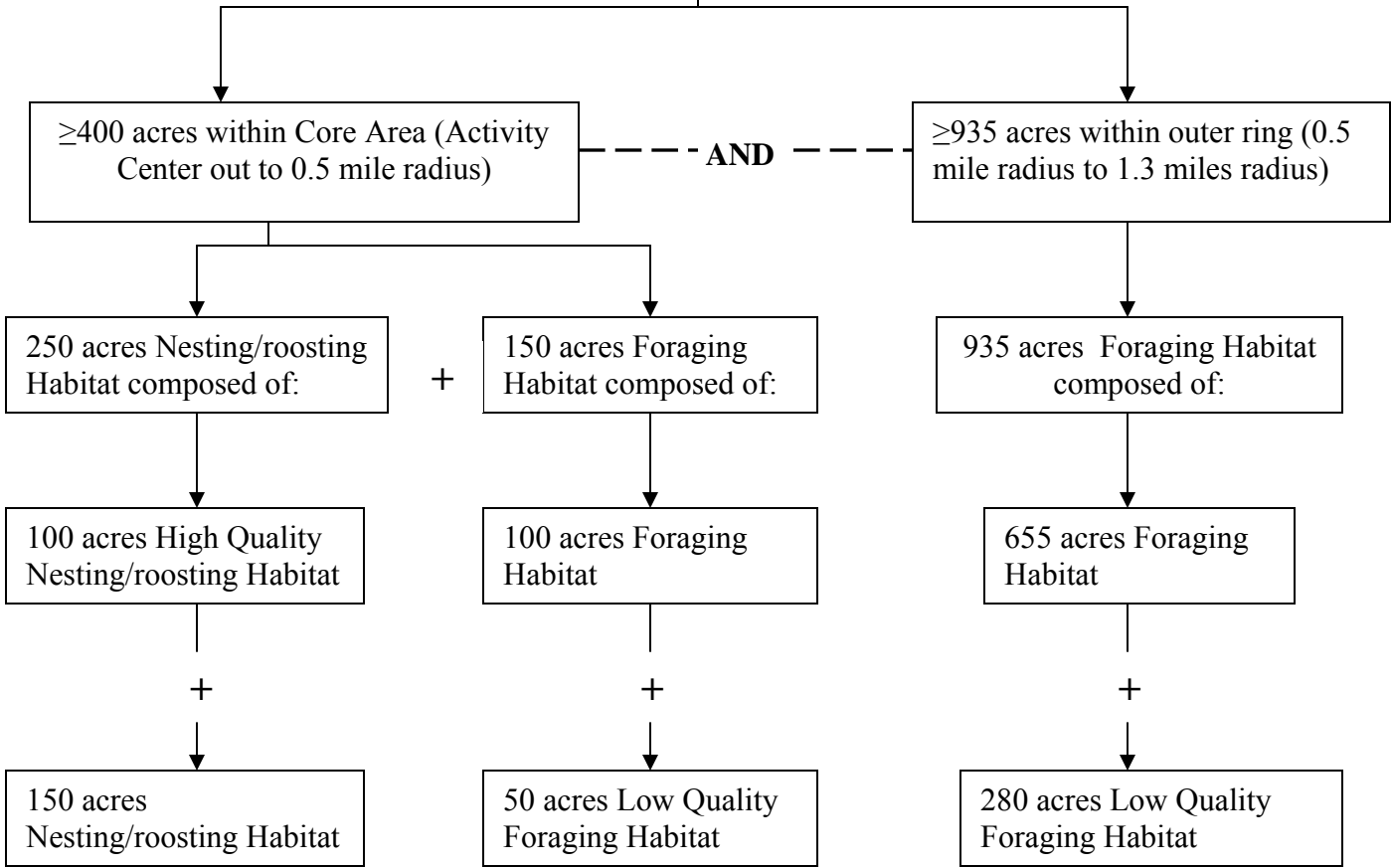
- 1) If surveys are inadequate or do not meet the intent of protocol, take determination may not be possible.
- 2) If habitat typing is inadequate, take determination may not be possible.
- 3) If NSO home range habitat acres are below desired conditions (Section III. 2, 3, and 4), additional loss of suitable habitat can lead to take.
- 4) If NSOs are nesting, utilize seasonal restriction within 0.25 mile of nest (February 1 through August 31).
- 5) If effects are limited to noise disturbance, a modified seasonal restriction may be used from February 1 through July 9

- a. Harvest of unsuitable habitat, with unsurveyed suitable within 0.25 of unit boundary
- 6) Multiple THPs located within a given NSO territory need to be considered collectively or a take determination may not be possible.

V. TA Letter Contents

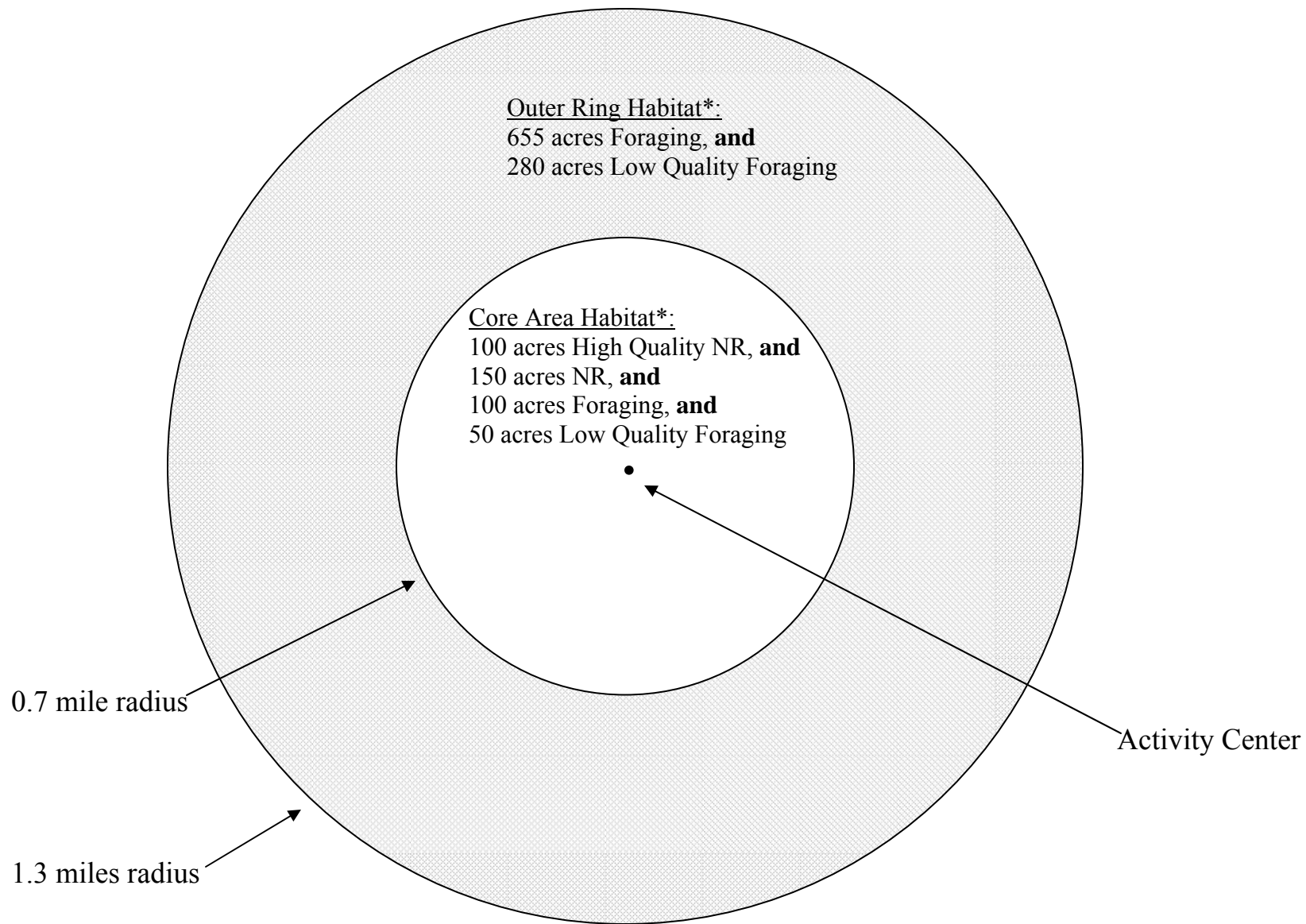
- 1) Date of written TA request
- 2) Date request received
- 3) Note if previous TA(s) provided in past
- 4) Number of acres within THP units
- 5) Amounts and types of silviculture prescriptions
- 6) Location of THP
 - a. Township, Range, and Section
 - b. Meridian
 - c. County
- 7) Identify NSO activity centers returned by CDFG reports
- 8) Surveys conducted and activity center status
- 9) Logic behind take determination
 - a. Habitat considerations
 - i. Acres, quality, and location of suitable habitat pre- and post-harvest
 - ii. Effects of timber operations on suitable habitat
 1. Degrade: suitable habitat is harvested but still functions in the capacity it did pre-harvest (i.e. Foraging habitat before harvest functions as foraging habitat post-harvest, nesting/roosting habitat pre-harvest functions as nesting/roosting habitat post-harvest)
 2. Downgrade: pre-harvest nesting/roosting habitat becomes foraging habitat post-harvest
 3. Remove: nesting/roosting or foraging habitat is harvested such that it no longer functions as habitat post-harvest
 - b. Proximity of activity center to operations
 - c. Survey data
- 10) Sunset date and seasonal restrictions
 - a. If 2 year protocol and surveys are current and negative, additional TA needed if operations not completed by February 1, *YEAR* (review protocol page 3).
 - b. If 1 year protocol and surveys are current and negative, additional TA needed if operations not completed by February 1, *YEAR* (review protocol page 3).
 - c. If NSOs detected in previous surveys and operations are not complete before February 1, surveys are required to determine location and status of NSOs prior to operations during each breeding season that operations are ongoing.
 - d. If no owls within 1.3 miles of THP (CDFG reports) and no suitable habitat within units or 1.3 miles of units, additional technical assistance may not be required.
- 11) Name of agency person to contact if there questions regarding TA

Habitat* Retention Acres (≥ 1335) by Distance from



*See Section III.2 for habitat definitions

Habitat Retention within Core Area and 1.3 mile Home Range–Interior



*See Section III.2 for habitat definitions

