United States Department of the Interior

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In Reply Refer To:
AFWO-17B0007-17F0010

NOV 23 2016

Merv George
Forest Supervisor
Six Rivers National Forest
1330 Bayshore Way
Eureka, California 95501

Subject: Formal Consultation on the Smith River National Recreation Area Restoration and Motorized Travel Management Project, Smith River Recreation Area, Six Rivers National Forest, Del Norte County, California

Dear Mr. George:

This document transmits the Fish and Wildlife Service's (Service) biological opinion (BO) based on our review of the Smith River National Recreation Area Restoration and Motorized Travel Management Project (Project), Smith River National Recreation Area and Gasquet Ranger District (NRA), Six Rivers National Forest (SRNF), and its effects on the federally threatened marbled murrelet (*Brachyramphus marmoratus*; murrelet) and northern spotted owl (*Strix occidentalis caurina*; spotted owl). Because you determined that the Project will have no effect on designated critical habitat for murrelets, designated murrelet critical habitat will not be addressed further in this document. However, you did determine that the Project may affect, but was not likely to adversely affect, designated critical habitat for the spotted owl (77 FR 14062). Your determination was based on the fact that less than 17 acres of dispersal habitat (Primary Constituent Element [PCE] 4) will be degraded at multiple 0.1-acre culvert removal sites within the action area over the 15 years of this Project. Because there is a large amount (i.e., 84,128 acres[1]) of designated spotted owl critical habitat in the action area, you determined that the function of designated critical habitat in action area was not expected to be adversely impacted. Considering the expected small amount of designated critical habitat to be degraded, we concur

[1] Includes portions of the Redwood Coast Unit, Subunit RDC1 (7,970 acres in the action area); the Klamath West Unit, Subunit KLW5 (24,319 acres in the action area); and Klamath West Unit, Subunit KLW6 (51,839 acres in the action area); and includes 993 acres of dispersal habitat (PCE 4) in RDC1, 3,499 acres in KLW5, and 5,454 acres in KLW 6.

with your determination and consider the amount of designated critical habitat to be degraded as insignificant.

This document was prepared in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). On September 16, 2016, we received your request for formal consultation and associated biological assessment (BA), dated September 12, 2016. This BO is based on information in the September 12, 2016, BA.

Consultation History

- In 2007, the Service issued a non-jeopardy biological opinion on the Project (see Service correspondence 8-14-2007-3069). Prior to the Project's implementation, the Project was appealed under the Forest Service process, the decision rescinded, and the SRNF subsequently revised the Project.

- On October 31, 2013, and March 24, 2015, the Project was again reviewed by the Level 1 Team, and the Level 1 team agreed that the 2007 determinations were still valid. The Level 1 team is comprised of a representative of the SRNF and the Service.

- On November 12, 2013, the Service received a first draft BA from the SRNF.

- On September 16, 2016, the Service received a complete BA from the SRNF and consultation was initiated.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROJECT

This Project will upgrade, downgrade, repair, or decommission National Forest Transportation System (NFTS) roads on the NRA, and will improve some unauthorized routes and designate them as NFTS roads or trails. Specifically, the following actions are proposed by the SRNF:

1. Designation of 18 unauthorized routes as NFTS roads, totaling 4 miles;
2. Designation of 81 unauthorized routes as NFTS motorized trails, totaling 56 miles (12 miles of which will be closed to motorized vehicles);
3. Seasonal gate closure on 10 roads and 7 motorized trails, totaling 34 miles;
4. Downgrading of 2 NFTS roads (17N49 and 17N07) from being appropriate for passenger vehicles to only being appropriate only for high clearance vehicles, totaling 15 miles;
5. Decommissioning of 112 NFTS roads, totaling 54 miles;
6. Restoration of 217 unauthorized roads totaling 93 miles;
7. Downgrading of 22 open NFTS roads to roads closed to vehicular traffic but available for future use, totaling 21 miles; and
8. Adding 4 parking areas on 17N49.

To accomplish these actions, the SRNF will conduct the following activities:

1. Re-establish former Drainage Patterns (Outslope and Waterbar) – These activities use heavy equipment and are aimed at re-establishing former drainage patterns. These water dispersion strategies are all designed to minimize stream diversion potential (i.e., prevent water from flowing down the road or trail), which minimizes the potential for off-site sediment delivery.
2. Remove Culverts and Associated Fill – These activities use heavy equipment and are aimed at re-establishing drainage patterns.
3. Install Barricades – This includes the placement of a barrier at the entrance to a road or route. The objectives are to prevent motorized use and to allow for revegetation.
4. Enact Seasonal Gate Closures – Reinforcing the seasonal closure through the installation of a gate is one of the management actions identified as a method to reduce the risk of spread of *Phytophthora lateralis* root disease to Port Orford-cedar (*Chamaecyparis lawsoniana*; POC) populations. Seasonal gate closure dates vary depending on location and existing ground conditions, but in general, the dates range from October to May.
5. Reinforce Gravel – Reinforce existing gravel on routes or add new gravel along sections of road near POC to reduce vehicle contact with mud and the spread of *Phytophthora lateralis* root disease to POC populations.
6. Delineate Routes – Placement of a physical barrier to travel, such as large boulders or other imported material, in close proximity to the motorized trail prism, designed to keep vehicular traffic on the designated route.
7. Post Speed Limits – Posting speed limits to reduce travel speed is aimed at reducing dust generation and the potential for inhaling dust that may contain asbestos.
8. Provide Public Information – This is aimed at increasing public awareness about the potential exposure to asbestos while traveling on newly added service roads and motorized trails, and the risk associated with exposure. Information may be made available in maps and literature available at the Ranger District office, or through signage posted on newly added NFTS roads and motorized trails.
9. Stormproof – This is a suite of management activities that will be applied to NFTS roads and trails to reduce water quality and sedimentation risks through culvert and road surface improvements, including redesigning of culverts for fish passage.

10. Install Culverts and Rolling Dips – These water dispersion, and/or containment strategies are all designed to minimize stream diversion potential (i.e., prevent water from flowing down the road or trail), protecting the travel route, as well as, minimizing the potential for off-site sediment delivery. The term "culvert" includes cross drains and stream crossings. These activities use heavy equipment.
11. Repair/Replace Culverts – This activity uses heavy equipment and includes upsizing culverts to pass the 100-year flood flow and associated debris.
12. Remove Culverts and Associated Fill – When applied to NFTS roads remaining on the NFTS, this action is limited to roads that are closed to vehicular traffic for greater than 1 year, but still exist on the SRNF transportation system for potential future use.

Conservation Measures

When used in the context of the Act, "conservation measures" represent actions proposed by the project proponent that are intended to further the recovery of and/or to minimize or compensate for project effects on the species under review. Because conservation measures are pledged in the project description by the action agency, their implementation is required under the terms of the consultation (Service and National Marine Fisheries Service 1998). The following conservation measures will be implemented as part of the Project to minimize potential effects to murrelets and spotted owls:

1. All unsurveyed murrelet and spotted owl nesting habitat, regardless of habitat quality, will be considered occupied.

2. Use of heavy equipment and other noise generating activities will not occur in areas within 0.25 mile of a known occupied murrelet site from March 24 to September 15.

3. Except for restoration, decommissioning, or upgrading on High Priority/High Risk Roads or Routes, use of heavy equipment and other noise generating activities will not occur between March 24 and August 5 within 0.25 mile of unsurveyed low-quality murrelet nesting habitat unless surveys determine the habitat is unoccupied. In addition, work in unsurveyed low-quality murrelet nesting habitat between August 5 and September 15 will not begin until 2 hours after sunrise and will stop 2 hours before sunset; this diurnal restriction will remain in place unless surveys determine the habitat is unoccupied.

4. Except for restoration, decommissioning, or upgrading on High Priority/High Risk Roads Routes, use of heavy equipment and other noise generating activities will not occur between March 24 and September 15 within 0.25 mile of unsurveyed high-quality murrelet nesting habitat, unless surveys determine the habitat is unoccupied.

5. Use of heavy equipment and other noise generating activities will not occur in areas within 0.25 mile of any known spotted owl activity center from February 1 to July 31.

6. Except for restoration, decommissioning, or upgrading on High Priority/High Risk Roads Routes, use of heavy equipment and other noise generating activities will not occur

between February 1 and July 9 within 0.25 mile of unsurveyed spotted owl nesting/roosting habitat, unless surveys determine the habitat is unoccupied.

7. No suitable nesting, roosting, or foraging habitat for spotted owl, and no suitable nesting habitat for murrelet will be affected by this Project.

8. No snags will be felled unless they pose a safety hazard, and all hazard trees felled would be left on site.

Time-frame of Biological Opinion

This BO covers actions to be taken for the 15 year period following completion of consultation.

STATUS OF THE SPECIES

Marbled Murrelet – See Appendix A.

Northern Spotted Owl – See Appendix B.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR §402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions, which are contemporaneous with the consultation process.

Definition of the Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). The action area for the Project encompasses the entire Smith River NRA and Gasquet Ranger District extended to include all spotted owl home ranges affected by the Project; therefore, the action area is 367,368 acres total.

Status of the Species in the Action Area

Marbled Murrelet

Although there are at least two known occupied murrelet sites in the action area, there are currently no known occupied sites within 0.25 mile of proposed noise-generating activities. There are approximately 83,079 acres of suitable murrelet habitat in the action area. Although murrelets are not widely distributed in the action area, based on the limited survey information and high amounts of suitable habitat, there are likely other currently unidentified occupied sites in the action area. However, no surveys have been conducted specifically for this Project;

therefore, all unsurveyed marbled murrelet nesting habitat will be considered occupied for the purposes of this consultation.

Northern Spotted Owl

There are 44 known spotted owl activity centers (ACs) in the action area. Approximately one-half of the lands in the action area (178,046 acres) are considered suitable spotted owl habitat. Given the wide distribution of spotted owls and suitable habitat in the action area, there are almost certainly other ACs that are currently unidentified. However, no surveys have been conducted specifically for this Project; therefore, all unsurveyed spotted owl nesting/roosting habitat will be considered occupied for the purposes of this consultation.

EFFECTS OF THE ACTION

This section presents an analysis of the direct and indirect effects of the proposed action on the murrelet and spotted owl, together with the effects of other activities that are interrelated or interdependent with the proposed action. Interrelated actions are those that are part of the larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. These effects are evaluated along with the environmental baseline and the predicted cumulative effects to determine the overall effects to the species.

Scientific Basis for Evaluating Potential Effects on Marbled Murrelet and Northern Spotted Owl

Project activities have the potential to adversely affect murrelets and spotted owls through habitat modification and disturbance. Due to the incomplete nature of murrelet and spotted owl survey data, the known presence of these species within the action area and adjacent lands, and the extent of suitable habitat for both species in the action area, we believe there are other occupied sites that have yet to be identified in the vicinity of the areas where work may occur during the breeding season. Furthermore, these areas are scattered throughout the action area, increasing the likelihood that some unsurveyed occupied sites will be affected. Accordingly, there is a reasonable certainty that some murrelets and owls will be adversely affected during implementation of this Project.

Habitat Modification

Habitat modification can directly or indirectly affect marbled murrelets and spotted owls at either site-specific or landscape scales. These effects may include a complete loss of habitat (removal), degradation of habitat, and other changes in habitat conditions which affect protection from the environment or predators.

Any individual or suite of site-specific effects could change the habitat function that a forested stand provides for murrelets or spotted owls. For the purpose of the following discussion, the degree of change to habitat function is categorized as either "removal" or "downgrading." The term removal represents a complete loss of habitat function following an effect. For example, an area that functioned as spotted owl nesting habitat before the action would no longer function as

nesting (or even foraging) habitat after the action. For spotted owl habitat, downgrading indicates a reduction in habitat quality. For example, an area that functioned as nesting habitat prior to an action would function as foraging habitat after the action. Downgrading of habitat should not be confused with downgrading of roads as discussed in DESCRIPTION OF THE PROJECT, above.

Generally, the Service considers actions that remove or downgrade suitable spotted owl habitat to below 400 acres of suitable[2] habitat (250 acres of which must be nesting/roosting) within 0.5 mile of an AC (the core use area), or to below 1,335 acres of suitable within 1.3 miles of an AC (the home range), as having the potential to result in incidental take of spotted owls. No similar guidelines exist for murrelets.

Disturbance

Road restoration, decommissioning, or upgrading activities, which require the use of heavy equipment and chainsaws, introduce high levels of noise into the environment. The effects of auditory and visual disturbances on birds are extremely difficult to determine (Knight and Skagen 1988). Confounding factors include: the tolerance level of individual birds; type and frequency of human activity; ambient sound levels; how sound reacts with topography and vegetation; and differences in how species perceive noise and human presence. Regardless of these difficulties, research conducted on a variety of bird species suggests that the effects of human disturbance can have a negative impact on reproductive success (Carney and Sydeman 1999; Frid and Dill 2002; Marzluff and Neatherlin 2006). Disturbance can affect productivity in a number of ways, including interference of courtship (Bednarz and Hayden 1988), nest abandonment (White and Thurow 1985), egg and hatchling mortality due to exposure and predation (Drent 1972; Swensen 1979), and altered parental care (Fyfe and Olendorrf 1976; Bortolotti *et al.* 1984).

Disturbance, in the context of road restoration, decommissioning, or upgrading and similar forestry activities, is defined in this consultation as noise in excess of ambient levels in, or within, 0.25 mile of suitable nesting habitat; or as the reaction of nesting birds to human presence or activity, resulting in disruption of essential breeding behaviors. Disturbance during the breeding season may potentially disrupt the species' essential breeding behaviors by: 1) causing abandonment of the breeding effort by failure to initiate nesting or to complete incubation; 2) disrupting nesting activity, such as feeding young; and 3) causing premature dispersal of juveniles (Service 2006).

Data on timing of various aspects of the breeding season indicate that murrelets in California have the longest breeding period of any North American bird species. Incubation commences as early as March 24 and ends as late as August 13; the nestling period may begin April 24 and end September 9 (Hamer and Nelson 1995). Data from murrelet populations throughout North America show that approximately 84 percent of murrelet young fledge from their nests by August 18 (Hamer and Nelson 1995). In California, we have defined the murrelet breeding season as the period from March 24 through September 15. We consider use of motorized equipment, near occupied or unsurveyed suitable murrelet habitat during the breeding season

[2] "Suitable" spotted owl habitat is comprised of nesting, roosting and foraging habitats.

(March 24 through September 15), to have the potential to significantly disrupt essential murrelet behaviors. Murrelets typically feed young and do nest exchanges around dusk or dawn. Accordingly, in some situations diurnal restrictions on noise generating activities around dusk and dawn are implemented to reduce the risk of disturbing murrelets during these times.

In California, we have defined the spotted owl breeding season as the period from February 1 through September 15. By July 10 the majority of young owls have fledged from the nest. Therefore, after July 9 we would not expect noise disturbance to result in abandonment of the breeding effort, disruption of nesting activities, or premature dispersal of juveniles.

Direct Injury or Mortality

In some situations, road restoration, decommissioning, or upgrading could result in direct mortality of adult murrelets or spotted owls, eggs, or chicks. For example, falling trees could strike and kill or injure a marbled murrelet or spotted owl. However, no marbled murrelet breeding habitat is expected to be modified. In addition, no habitat for northern spotted owls is expected to be modified, except dispersal habitat. Therefore, we do not expect that adult or young murrelets or spotted owls will be directly injured or killed during Project implementation.

Effects of the Action

Habitat Modification

No suitable nesting, roosting, or foraging habitat for spotted owl, and no suitable nesting habitat for murrelet will be modified or removed. However, in culvert removal during restoration, decommissioning or stormproofing, upgrades will necessitate fill removal and recontour of stream crossings. Culvert removal may require minor amounts of vegetation modification (usually 0.01 acre or less) of brush and smaller diameter trees (saplings up to 11 inches diameter at breast height) at multiple sites, resulting in a maximum of 17 acres of spotted owl dispersal habitat that may be degraded over 15 years. However, no large diameter or predominant trees will be removed.

Disturbance

We cannot estimate the exact number of adult murrelets or spotted owls that might be affected, because Project-specific surveys have not been conducted. Therefore, to minimize potential effects from noise disturbance to murrelets and spotted owls, use of heavy equipment and other noise generating activities will generally not be conducted within 0.25 mile of unsurveyed suitable nesting/roosting habitat or within 0.25 mile of known murrelet or spotted owl sites during the breeding season. However, restoration, decommissioning, or upgrading on High Priority/High Risk Roads and Routes may occur during the breeding season within 0.25 mile of unsurveyed suitable nesting/roosting habitat.

There are 76 roads designated as High Priority/High Risk Roads and Routes where work will potentially occur during the murrelet or spotted owl breeding season. For these roads, road work (decommissioning/restoration and stormproofing) cannot be accomplished within the limited

operating period for murrelet and spotted owl due the amount of work needed (number of culverts to be removed/replaced, etc.). Not all the roads or all segments of each road are within 0.25 mile of suitable murrelet and spotted owl nesting habitat; 52 of these roads at least partially occur within 0.25 mile of suitable, unsurveyed murrelet and spotted owl nesting habitat that is presumed to be occupied. As a result, 2,701 acres of murrelet nesting habitat, and 3,914 acres of spotted owl nesting/roosting habitat may be disturbed during the breeding season. It is expected that 540 acres of murrelet nesting habitat, and 782 acres of spotted owl nesting/roosting habitat will be disturbed each year of the Project. Within the action area, approximately 3.3% and 2.2% of the total amount of suitable habitat for murrelet and spotted owl, respectively, will be disturbed during the breeding season over 15 years.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur within the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Any future Federal activities that occur within the action areas and have the potential to affect any listed species will have a Federal nexus and require section 7 consultation with the Service.

The only future State, tribal, local, or private actions that is reasonably certain to occur within the action area during the life of the Project is a thinning project on 133 acres of private land.

CONCLUSION

After reviewing the current status of the murrelet and spotted owl, the environmental baseline, the effects of the action, and the cumulative effects, it is the Service's biological opinion that this Project does not jeopardize the continued existence of the murrelet or spotted owl.

The Service reached these non-jeopardy conclusions based on the following factors:

Marbled Murrelet

1. No suitable murrelet nesting habitat will be modified.
2. No known occupied murrelet sites will be disturbed during the breeding season.
3. The conservation measures proposed as part of the Project will minimize the potential for disturbance to nesting murrelets and their young.

Northern Spotted Owl

1. No suitable spotted owl nesting/roosting or foraging habitat will be modified, and only a small amount (17 acres) of dispersal habitat will be degraded over a 15-year period.

2. No known occupied spotted owl sites will be disturbed during the breeding season.

3. The conservation measures proposed as part of the Project will minimize the potential for disturbance to spotted owls and their young.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the taking of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

AMOUNT OR EXTENT OF TAKE

As discussed above, the actual effects of auditory and visual disturbances on birds are extremely difficult to determine, especially the effects of disturbance on the production of young. Noise and visual disturbance are likely to significantly disrupt normal murrelet and spotted owl nesting behaviors. Anticipated responses to disturbance include flushing from a nest or branch within nesting habitat, aborted or delayed feeding of juveniles, and/or increased vigilance/alert behaviors at nest sites. These behavioral disruptions create a likelihood of injury by increasing the risk of failed nesting attempts due to predation and/or through reduced fitness of nestlings caused by missed feedings.

Current survey methodology does not provide estimates of the number of murrelets present in a given area. Generally, spotted owl survey methods do allow quantification of the number of breeding adults present in a given area, but with the rising prevalence of barred owls the reliability of those surveys are reduced. In both species, however there is no available methodology to quantify or monitor the effects of noise disturbance on reproductive success of individuals. Based on the known distribution of murrelets, spotted owls, and their nesting habitat in the action area, the Service believes murrelets and spotted owls will be present in the areas that may be disturbed during the breeding season.

Because it is not practical to quantify or monitor the number of murrelets or spotted owl young that might be incidentally taken as a result of auditory and visual disturbance during project implementation, acres of habitat disturbed will be used as a surrogate, in accordance with regulations at 50 CFR 402.14(i)(1)(i). The acres of habitat disturbed will be the metric used to

monitor take-related impacts, and to determine if the level of anticipated take has been exceeded. The Service does not anticipate that any adult murrelets or spotted owls will be taken.

Marbled Murrelet

An unknown number of nesting murrelets associated with 2,701 acres of suitable nesting habitat may be taken, in the form of harassment, as a result of noise disturbance from restoration, decommissioning, or upgrading activities.

Northern Spotted Owl

An unknown number of nesting spotted owls associated with 3,914 acres of suitable nesting/roosting habitat may be taken, in the form of harassment, as a result of noise disturbance from restoration, decommissioning, or upgrading activities.

EFFECT OF THE TAKE

Within the action area, approximately 3.3% and 2.2% of the total amount of suitable habitat for murrelet and spotted owl, respectively, will be disturbed during the breeding season over 15 years. Accordingly, the Service determined that this low level of anticipated take is not likely to result in jeopardy to the murrelet or spotted owl.

REASONABLE AND PRUDENT MEASURES

Pursuant to 50 CFR §402.14 (I)(ii), reasonable and prudent measures are those the Service considers necessary to minimize the impact of the incidental taking. Impacts of the proposed action largely will be minimized by compliance with measures incorporated into the Project. Consequently, no reasonable and prudent measures are necessary.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the SRNF must comply with terms and conditions, which implement the reasonable and prudent measures described above. Because no reasonable and prudent measures are necessary, no terms and conditions are necessary.

MONITORING REQUIREMENTS

In order to monitor the impacts of incidental take, the SRNF must report the progress of the action and its impacts (by acres disturbed) on murrelet nesting habitat and spotted owl nesting/roosting habitat. This reporting shall be completed prior to January 31 of each year through 2032.

REPORTING REQUIREMENTS

Any dead or injured murrelet or spotted owl must be reported to the Arcata Fish and Wildlife Office as soon as possible, and turned over to the same for care or analysis. The Service is to be notified in writing within three working days of the accidental death of, or injury to, a murrelet or spotted owl or of the finding of any dead or injured murrelet or spotted owls during implementation of the proposed action. Notification must include the date, time, and location of the incident or discovery of a dead or injured murrelet or spotted owl, as well as any pertinent information on the circumstances surrounding the incident of discovery. The Service contact for this information is John Hunter at the Arcata Fish and Wildlife Office at (707) 822-7201.

CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species and the ecosystems upon which they depend. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We have no conservation recommendations for this consultation.

REINITIATION NOTICE

This concludes formal consultation on the action. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may have affected listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action.

If you have any questions regarding this biological opinion, please contact John Hunter of my staff at the above letterhead address or phone number.

Sincerely,

for Stefanie K Richards

Bruce Bingham
Field Supervisor

cc:
USFS, Smith River National Recreation Area, Gasquet, California (Attn: Brenda Devlin)

APPENDIX A

Status of the Species – Marbled Murrelet

Legal Status

The marbled murrelet (*Brachyramphus marmoratus*) was listed as a threatened species on September 28, 1992, in Washington, Oregon, and northern California (57 FR 45328 [October 1, 1992]). Since the species' listing, the Service has completed two 5-year status reviews of the species: September 1, 2004 (Service 2004a) and June 12, 2009 (Service 2009). The legal status of the marbled murrelet remains unchanged from the original designation.

The Service originally designated critical habitat for the marbled murrelet in Washington, Oregon, and California on May 24, 1996 (61 FR 26256). The Service revised the 1996 rule in October 2011 (76 FR 61599).

Taxonomy and Range

The marbled murrelet is a small seabird that inhabits the coastal forests and nearshore marine environment along the Pacific coast of North America from southern California to southern Alaska and the Aleutian Islands (Carter and Morrison 1992; Ralph *et al.* 1995; Nelson 1997). The long-billed murrelet (*B. perdix*) and Kittlitz's murrelet (*B. brevirostris*), which are mostly restricted to northeastern Asia and Alaska, respectively, are the only other species in the Brachyramphus genus worldwide. The long-billed and marbled murrelets were long considered to be two races of the same species, despite several morphological differences. However, in 1997, the American Ornithologists' Union recognized the marbled and long-billed murrelets as separate species (American Ornithologists' Union 1997).

The breeding range of the marbled murrelet extends along the Pacific coast from Alaska to Monterey Bay in central California. Some wintering birds occur as far south as northern Baja California, Mexico. However, only the Washington, Oregon, and California population segment is federally listed as threatened (Service 1997).

Limited information is available on their historical distribution and numbers; however, most summaries give indications that the distribution of marbled murrelet populations was significantly reduced as habitat was removed throughout its' range. Populations declined as a result. In some areas, only small numbers of marbled murrelets persist or have been locally extirpated, risking maintenance of the species' distribution. These areas are identified as "areas of concern" (Service 1997). They include distribution gaps in central California, northwestern Oregon, and southwestern Washington, where very little suitable habitat remains, and what habitat does remain occurs in small, fragmented patches.

Biology and Ecology

Marbled murrelets are long-lived seabirds that spend most of their life in the marine environment, with breeding adult birds annually nesting in the forest canopy of mature and old-

growth forests. Breeding occurs from about March 24 through September 15, is asynchronous, and spread over a more prolonged season than for most temperate seabirds. Marbled murrelets have a naturally low reproductive rate. Marbled murrelets lay just one egg, and are thought to usually first breed at age 3. Renesting in the event of nest failure appears to be uncommon, but does occur (Hebert *et al.* 2003; Piatt *et al.* 2007). Incubation is shared by both sexes with incubation shifts lasting 24 hours and exchanges occurring at dawn (Nelson 1997). Chicks fledge 27-40 days after hatching (Nelson 1997).

Marbled murrelets are known to be opportunistic feeders, diving after small schooling fish and large pelagic crustaceans (euphausiids, mysids, amphipods). They will carry a single energy-dense fish to their chick: typically larger sand lance, immature herring, anchovy, smelt, and occasionally salmon smolts (Carter and Sealy 1990; Nelson 1997). Radio marked marbled murrelets in California confirm that breeders forage more closely to nesting habitat once nesting is initiated than non-breeders (Peery *et al.* 2009; Hebert and Golightly 2008).

Habitat Use

Throughout most of its breeding range, including the listed range from Washington to California, the marbled murrelet uses old-growth coniferous forest habitat for nesting and forages in the nearshore marine environments. Nests are not built, but rather the egg is placed in a small depression or cup made in moss or other debris on the limb (Service 1997). At the north end of the range, ground-nesting occurs in the Aleutian Islands and parts of southern Alaska. The distance inland that marbled murrelets breed is variable and influenced by a number of factors; however, the Service considers 50 miles (80 kilometers (km)) as the maximum inland distance for determining habitat suitability and amount of habitat within the listed range (Service 2009).

In California, recent radio marked marbled murrelets confirm that breeders forage more closely to nesting habitat once nesting is initiated than non-breeders (Peery *et al.* 2009; Hebert and Golightly 2008). In northern California, mean home range size was 655 kilometer squared (km2) for non-nesters and 240 km2 for nesters (Hebert and Golightly 2008). Mean along shore movement was 69 km for nesting females and 78 km for nesting males (Hebert and Golightly 2008). Mean offshore movement was within 1.4 km regardless of sex or nesting status (Hebert and Golightly 2008). In central California, nesting birds spent night time hours resting on the ocean an average of 5.1 km from the mouths of drainages used to reach nesting habitat, and commuted from these resting areas to daytime foraging locations (Peery *et al.* 2009). These at-sea resting areas associated with inshore nesting habitat appear important to breeding marbled murrelets as they are constrained by the need to attend nest sites (Peery *at el.* 2009). Non-breeders often spent the night near daytime foraging areas (Peery *et al.* 2009).

In Washington, home range size during the breeding season was more variable. Here, average marine home range size was five times larger in 2005 (2,098 km2) compared to 2004 (469 km2) during the breeding season (Bloxton and Raphael 2006). In 2004, the radio-tagged marbled murrelets had relatively confined home ranges within a single part of the study area. However, in 2005, they used multiple core feeding areas, likely in response to poor oceanographic conditions (Bloxton and Raphael 2006). These numbers include both nesting and nonnesting individuals, and the 2005 mean home range size was considerably larger than observed in

northern California by Hebert and Golightly (2008). Overall, there appear to be differences in home range size and use across the range. This may be related to habitat use and forage availability.

Threats

Several threats to marbled murrelets, present in both the marine and terrestrial environments, have been identified. These threats collectively comprise a suite of environmental stressors that, individually or through interaction, have significantly disrupted or impaired behaviors which are essential to the reproduction or survival of individuals. When combined with the species naturally low reproductive rate, these stressors have led to declines in marbled murrelet abundance, distribution, and reproduction at the population scale within the listed-range.

When the marbled murrelet was listed under the Endangered Species Act (October 1, 1992; 57 FR 45328) and threats summarized in the Recovery Plan (Service 1997), several anthropogenic threats were identified as having caused the dramatic decline in the species.

- habitat destruction and modification in the terrestrial environment from timber harvest and human development caused a severe reduction in the amount of nesting habitat
- unnaturally high levels of predation resulting from forest "edge effects;"
- the existing regulatory mechanisms, such as land management plans (in 1992), were considered inadequate to ensure protection of the remaining nesting habitat and reestablishment of future nesting habitat; and
- manmade factors such as mortality from oil spills and entanglement in fishing nets used in gill-net fisheries.

There have been changes in the levels of these threats since the 1992 listing (Service 2004; Service 2009). The regulatory mechanisms implemented since 1992 that affect land management in Washington, Oregon, and California (for example, the Northwest Forest Plan (NWFP)) and new gill-netting regulations in northern California and Washington have reduced the threats to marbled murrelets (Service 2004a). The threat levels for the other threats identified in 1992 listing (57 FR 45333-45336) including the loss of nesting habitat, predation rates, and mortality risks from oil spills and gill net fisheries (despite the regulatory changes) remained unchanged following the Service's 2004, 5-year, range-wide status review for the marbled murrelet (Service 2004a).

However, new threats were identified in the Service's 2009, 5-year review for the marbled murrelet (Service 2009). These new stressors are due to several environmental factors affecting marbled murrelets in the marine environment. These new stressors include:

- Habitat destruction, modification, or curtailment of the marine environmental conditions necessary to support marbled murrelets due to:
    - elevated levels of polychlorinated biphenyls in marbled murrelet prey species;
    - changes in prey abundance and availability;
    - changes in prey quality;

  - harmful algal blooms that produce biotoxins leading to domoic acid and paralytic shellfish poisoning that have caused marbled murrelet mortality; and
  - climate change in the Pacific Northwest.

- Manmade factors that affect the continued existence of the species include:
  - derelict fishing gear leading to mortality from entanglement;
  - energy development projects (wave, tidal, and on-shore wind energy projects) leading to mortality; and
  - disturbance in the marine environment (from exposures to lethal and sub-lethal levels of high underwater sound pressures caused by pile-driving, underwater detonations, and potential disturbance from high vessel traffic, particularly a factor in Washington state).

Detailed discussions of the above-mentioned threats, life-history, biology, and status of the marbled murrelet are presented in the Federal Register, listing the marbled murrelet as a threatened species (57 FR 45328); the Recovery Plan (Service 1997), Ecology and Conservation of the Marbled Murrelet (Ralph *et al.* 1995); the final rule designating marbled murrelet critical habitat (May 24, 1996; 61 FR 26256); the Evaluation Report in the 5-Year Status Review of the Marbled Murrelet in Washington, Oregon, and California (McShane *et al.* 2004); the 2004 and 2009 5-year Reviews for the Marbled Murrelet (Service 2004a; Service 2009), and the final rule revising critical habitat for the marbled murrelet (October 5, 2011; 76 FR 61599).

Population Status

The initial at-sea surveys for marbled murrelets that began during the 1990s in the marine waters of Washington, Oregon, and California were generally independent and sporadic efforts to assess marbled murrelet population status (abundance, trends, distribution, and fecundity). In 1999, researchers developed the effectiveness monitoring (EM) plan for the NWFP (Madsen *et al.* 1999) brought a unified sampling protocol to assessing marbled murrelet population status and trend for the coastal marine waters offshore of the five Conservation Zones within the NWFP planning area. Standardized at-sea surveys using this protocol began in 2000, as part of the EM Program (Bentivoglio *et al.* 2002). At-sea surveys are also conducted in Conservation Zone 6, independent of the EM Program, but conducted using similar survey methods. The at-sea survey data collected prior to the EM Program are generally not suitable for statistical comparisons or trend analyses due to differences in survey methods (McShane *et al.* 2004).

<u>Abundance and Distribution</u>

Marbled murrelet abundance during the early 1990s in Washington, Oregon, and California was estimated at 18,550 to 32,000 birds (Ralph *et al.* 1995). Based primarily on the results from the EM Program, the 2011 marbled murrelet population for the listed range (Table 1) is estimated at about 23,000 birds (95 percent confidence interval [CI]: 17,691 – 28,364; Table 1). This number is higher than in the previous four years, when estimates were consistently below 18,000 birds (Miller *et al.* 2012). Based on the 2011 estimates, Conservation Zones 3 and 4 support approximately 60 percent of the marbled murrelet population within the U.S., and consistently

have the highest at-sea densities during the nesting season (Falxa *et al.* 2011). Marbled murrelets occur in the lowest abundance in Conservation Zones 5 and 6.

At the time of listing, the distribution of active nests in nesting habitat was described as non-continuous (Service 1997). The known distribution of murrelets in Conservation Zone 4 was was adjusted after systematic surveys indicated that areas further inland were unoccupied (Hunter *et al.* 1998). The at-sea extent of the species currently encompasses an area similar in size to the species' historical distribution, but with the extremely low density of marbled murrelets in Conservation Zone 5, and the small population in Conservation Zone 6, the southern end of the marbled murrelet distribution is sparsely populated compared to Conservation Zones 1-4.

Table 1. Estimates of marbled murrelet density and population size (95 percent confidence interval (CI)) in Conservation Zones 1 through 5 during the 2011 breeding season (Northwest Forest Plan Effectiveness Monitoring Program), and in Conservation Zone 6 during the 2011 breeding season (Henry *et al.* 2012).

Conservation Zone	**Density** (birds/km^2)	**Coefficient of Variation** (% Density)	**Population Size Estimates with 95% CI**			**Survey Area** (km^2)
			Number of Birds	Lower	Upper	
1	2.06	18.0	7,187	4,512	9,745	3,497
2	0.72	32.2	1,189	597	2,060	1,650
3	4.65	16.4	7,417	5,200	10,078	1,595
4	5.61	29.9	6,507	3,349	10,214	1,159
5	0.32	44.2	282	57	564	883
6	-	-	433	339	553	-
Zones 1-6	-	-	23,015	17,691	28,364	-

The at-sea distribution also exhibits discontinuity within Conservation Zones 1, 2, 5, and 6, where five areas of discontinuity are noted: a segment of the border region between British Columbia, Canada and Washington, southern Puget Sound, WA, Destruction Island, WA to Tillamook Head, OR, Humboldt County, CA to Half Moon Bay, CA, and the entire southern end of the breeding range in the vicinity of Santa Cruz and Monterey Counties, CA (McShane *et al.* 2004).

Trend

There are two general approaches that researchers use to assess marbled murrelet population trend: at-sea surveys and population modeling based on demographic data. In general, the Service assigns greater weight to population trend and status information derived from at-sea surveys than estimates derived from population models because survey information generally provides more reliable estimates of trend and abundance.

Marine Surveys

Researchers from the EM Program detected a statistically significant decline ($p < 0.001$) in the abundance of the population in Conservation Zones 1 through 5 combined, for the 2001-2010 sample period (Miller *et al.* 2012). The estimated average annual rate of decline for this period was 3.7 percent (95 percent CI: -4.8 to -2.7 percent). This rate of annual decline suggests a total population decline of about 29 percent between 2001 and 2010 (Miller *et al.* 2012).

At the scale of individual conservation zones for this period, the marbled murrelet population in Conservation Zone 1 declined at an estimated average rate of 7.4 percent per year (95 percent CI: -11.2 to -3.5) (Miller *et al.* 2012). In that same analysis, statistically significant trends were not detected elsewhere at the single-zone scale, but evidence of a declining trend was strong in Zone 2 (6.5% annual rate of decline, $P = 0.06$). For Washington State (Conservation Zones 1 and 2 combined) there was a 7.31 percent (standard error = 1.31 percent) annual rate of decline in marbled murrelet density for the 2001-2010 period (Pearson *et al.* 2011), which equates to a loss of approximately 47 percent of the marbled murrelet population since 2001. Subsequent to this analysis, the 2011 estimate for Conservation Zones 1 through 5 combined (Table 1) increased markedly in 2011, reflecting substantially higher estimates in Conservation Zones 1 and 4, compared to the estimates from recent prior years as reported by Miller *et al.* (2012). Whether the higher 2011 estimates represent a change in marbled murrelet numbers or trend, or a sampling artifact remains to be determined, pending additional years of population monitoring.

The 2008 population estimate for Conservation Zone 6 suggested a decline of about 55 percent from the 2007 estimate and a 75 percent decline from the 2003 estimate (Peery *et al.* 2008). However, in the most recent population estimate available, the 2011 estimate was greater than the 2007-2008 estimates, and somewhat lower than the 1999-2003 estimates (Henry *et al.* 2012). Henry *et al.* (2012) speculated that their recent results may be explained by marbled murrelets in central California moving out of the survey area in 2007 and 2008, and then subsequently returning.

Population Models

Prior to the use of survey data to estimate trend, demographic models were more heavily relied upon to generate predictions of trends and extinction probabilities for the marbled murrelet population (Beissinger 1995; Cam *et al.* 2003; McShane *et al.* 2004; Service 1997). However, marbled murrelet population models remain useful because they provide insights into the demographic parameters and environmental factors that govern population stability and future extinction risk, including stochastic factors that may alter survival, reproductive, and immigration/emigration rates.

In a report developed for the 5-year Status Review of the Marbled Murrelet in Washington, Oregon, and California (McShane *et al.* 2004), computer models were used to forecast 40-year marbled murrelet population trends. A series of female-only, multi-aged, discrete-time stochastic Leslie Matrix population models were developed for each conservation zone to forecast decadal population trends over a 40-year period with extinction probabilities beyond 40 years (to 2100). The authors incorporated available demographic parameters (Table 2) for each

conservation zone to describe population trends and evaluate extinction probabilities (McShane *et al.* 2004).

McShane *et al.* (2004) used mark-recapture studies conducted in British Columbia by Cam *et al.* (2003) and Bradley *et al.* (2004) to estimate annual adult survival and telemetry studies or at-sea survey data to estimate fecundity. Model outputs predicted -3.1 to -4.6 percent mean annual rates of population change (decline) per decade the first 20 years of model simulations in marbled murrelet Conservation Zones 1 through 5 (McShane *et al.* 2004). Simulations for all zone populations predicted declines during the 20 to 40-year forecast, with mean annual rates of -2.1 to -6.2 percent per decade (McShane *et al.* 2004). These reported rates of decline are similar to the estimates of -4 to -7 percent per year reported in the Recovery Plan (Service 1997).

Table 2. Rangewide marbled murrelet demographic parameter values based on four studies all using Leslie Matrix models.

Demographic Parameter	Beissinger 1995	Beissinger and Nur 1997*	Beissinger and Peery (2007)	McShane *et al.* 2004
Juvenile Ratio (Ŕ)	0.10367	0.124 or 0.131	0.089	0.02–0.09
Annual Fecundity	0.11848	0.124 or 0.131	0.06–0.12	-
Nest Success	-	-	0.16–0.43	0.38–0.54
Maturation	3	3	3	2–5
Estimated Adult Survivorship	85%–90%	85%–88%	82%–90 %	83%–92%

*In Service (1997).

McShane *et al.* (2004) modeled population extinction probabilities beyond 40 years under different scenarios for immigration and mortality risk from oil spills and gill nets. Modeled results forecast different times and probabilities for local extirpations, with an extinction risk[1] of 16 percent and mean population size of 45 individuals in 100 years in the listed range of the species (McShane *et al.* 2004).

Reproduction

Generally, estimates of marbled murrelet fecundity are directed at measures of breeding success, either from direct assessments of nest success in the terrestrial environment, marine counts of hatch-year birds, or computer models. Telemetry estimates are typically preferred over marine counts for estimating breeding success due to fewer biases (McShane *et al.* 2004). However, because of the challenges of conducting telemetry studies, estimating marbled murrelet reproductive rates with an index of reproduction, referred to as the juvenile ratio (Ŕ)[2], continues to be important, despite the debate over use of this index (see discussion in Beissinger and Peery 2007).

[1] Extinction was defined by McShane *et al.* (2004) as any murrelet conservation zone containing less than 30 birds.
[2] The juvenile ratio (Ŕ) for murrelets is derived from the relative abundance of hatch-year (HY; 0-1 year-old) to after-hatch-year (AHY; 1+ year-old) birds (Beissinger and Peery 2007) and is calculated from marine survey data.

Although difficult to obtain, nest success rates[3] are available from telemetry studies conducted in California (Hebert and Golightly 2006; Peery *et al.* 2004) and Washington (Bloxton and Raphael 2006). In northwest Washington, Bloxton and Raphael (2005) documented a nest success rate of 0.20 (2 chicks fledging from 10 nest starts). In central California, marbled murrelet nest success is 0.16 (Peery *et al.* 2004) and in northern California it is 0.31 to 0.56 (Hebert and Golightly 2006). No studies or published reports from Oregon are available.

Unadjusted and adjusted values for annual estimates of marbled murrelet juvenile ratios suggest extremely low breeding success in Conservation Zone 4 (mean ratio for 2000-2011 of 0.046, range 0.01 to 0.1; Crescent Coastal Research 2012), northern California (0.003 to 0.029; Long *et al.* 2008; Crescent Coastal Research 2012), central California (0.035 to 0.032; Beissinger and Peery 2007), and in Oregon (0.0254 to 0.0598; Crescent Coastal Research 2008). Estimates for **Ŕ** (adjusted) in the San Juan Islands in Washington have been below 0.15 every year since surveys began in 1995, with three of those years below 0.05 (Raphael *et al.* 2007).

These current estimates of **Ŕ** are assumed to be below the level necessary to maintain or increase the marbled murrelet population. Demographic modeling suggests marbled murrelet population stability requires a minimum reproductive rate of 0.18 to 0.28 (95 percent CI) chicks per pair per year (Beissinger and Peery 2007; Service 1997). The estimates for **Ŕ** discussed above from individual studies, as well as estimates for the listed range (0.02 to 0.13; Table 2) are all below the lowest estimated value (0.18) identified as required for population stability (Service 1997; Beissinger and Peery 2007).

The current estimates for **Ŕ** also appear to be well below what may have occurred prior to the marbled murrelet population decline. Beissinger and Peery (2007) performed a comparative analysis using historical data from 29 bird species to predict the historical **Ŕ** for marbled murrelets in central California, resulting in an estimate of 0.27 (95 percent CI: 0.15 - 0.65). Therefore, the best available scientific information of current marbled murrelet fecundity from model predictions, and from juvenile ratios and trend analyses based on of population survey data, appear to align well. Both indicate that the marbled murrelet reproductive rate is generally insufficient to maintain stable population numbers throughout all or portions of the species' listed range.

Summary: Marbled Murrelet Abundance, Distribution, Trend, and Reproduction

The 2010 estimated abundance for marbled murrelets within Conservation Zones 1-5 was the lowest recorded since inception of the EM program (Falxa *et al.* 2011), with the 2010 population size for the listed range of the species estimated at 17,322 birds (95 percent CI: 13,524 – 21,192). The confidence limits indicate that population estimates are not precise; however, this low number is consistent with a pattern of decreasing estimates from 2001 to 2010 (Falxa *et al.* 2011). Although marbled murrelets are distributed throughout their historical range, the area of occupancy within their historical range appears to be reduced from historical levels. The distribution of the species also exhibits five areas of discontinuity: (1) the British Columbia-Washington border region; (2) southern Puget Sound, WA; (3) Destruction Island, WA to

[3] Nest success here is defined by the annual number of known hatchlings departing from the nest (fledging) divided by the number of nest starts.

Tillamook Head, OR; (4) southern Humboldt County, CA to Half Moon Bay, CA; and (5) the southern end of the breeding range including Monterey County and southern Santa Cruz County, CA (McShane *et al.* 2004).

The overall population trend from the combined 2001-2010 population estimates (Conservation Zones 1 – 5 combined) indicate a significant, range-wide annual rate of decline of about 3.7 percent (95 percent CI: -4.8 to -2.7 percent; Falxa *et al.* 2011). In addition, at the single-zone scale, a decline was observed for the Conservation Zone 1 population, and there is strong evidence for a decline in Conservation Zone 2 for the same period (Falxa *et al.* 2011).

The current range of estimates for **Ŕ**, the juvenile to adult ratio, is below the level assumed to be necessary to maintain or increase the marbled murrelet population. Whether derived from marine surveys or from population modeling (**Ŕ** = 0.02 to 0.13, Table 2), the available information is in general agreement that the current reproductive success, as indicated by the ratio of hatch year birds to after-hatch year birds, is insufficient to maintain a stable marbled murrelet population throughout the listed range. The current estimates for **Ŕ** also appear to be well below what may have occurred prior to the marbled murrelet population decline (Beissinger and Peery 2007) and model predictions forecast an extinction risk of 16 percent over a 100-year period, with a 3-state mean population size of 45 individuals in 100 years in the listed portion of the species' range (McShane *et al.* 2004).

Thus, considering the best available data on abundance, distribution, population trend, and the low reproductive success of the species, the Service concludes the marbled murrelet population within the portion of its listed range currently has little or no capability to self-regulate, as indicated by the significant, annual decline in abundance the species is currently undergoing throughout the listed range. The Service expects the species to continue to exhibit further reductions in the distribution and abundance into the foreseeable future, due largely to the expectation that the variety of current environmental stressors present in the marine and terrestrial environments (discussed in the *Threats to Marbled Murrelet Survival and Recovery* section) will continue into the foreseeable future.

Conservation and Recovery

The Marbled Murrelet Recovery Plan outlines the conservation strategy with both short- and long-term objectives. The Plan places special emphasis on the terrestrial environment for habitat-based recovery actions due to nesting occurring in inland forests.

In the short-term, specific actions identified as necessary to stabilize the population include protecting occupied habitat and minimizing the loss of unoccupied but suitable habitat (Service 1997). Specific actions include maintaining large blocks of suitable habitat, maintaining and enhancing buffer habitat, decreasing risks of nesting habitat loss due to fire and windthrow, reducing predation, and minimizing disturbance. The designation of critical habitat also contributes towards the initial objective of stabilizing the population size through the maintenance and protection of occupied habitat and minimizing the loss of unoccupied but suitable habitat.

Long-term conservation needs identified in the Plan include:

- increasing productivity (abundance, the ratio of juveniles to adults, and nest success) and population size;
- increasing the amount (stand size and number of stands), quality, and distribution of suitable nesting habitat;
- protecting and improving the quality of the marine environment; and
- reducing or eliminating threats to survivorship by reducing predation in the terrestrial environment and anthropogenic sources of mortality at sea.

Recovery Zones

The Plan identified six Conservation Zones (Figure 1) throughout the listed range of the species: Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation Zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6). Recovery zones are the functional equivalent of recovery units as defined by Service policy (Service 1997).

Recovery Zones in California

Conservation Zone 4 extends from North Bend, Oregon to the southern end of Humboldt County, California. In general, it extends inland 35 miles (56 km) from the Pacific Ocean shoreline, and includes waters within 1.2 miles of the shoreline. Conservation Zone 5 extends south from the southern boundary of Humboldt County to the mouth of San Francisco Bay. It also includes marine waters within 1.2 miles of the Pacific Ocean shoreline, and extends inland a distance of up to 25 miles (40 km) from that shoreline. Conservation Zone 6 extends south from the mouth of San Francisco Bay to Point Sur, Monterey County, California; this zone includes marine waters within 1.2 miles of the Pacific Ocean shoreline, and extends inland a distance of up to 15 miles (24 km) from that shoreline (Service 1997).

Lands considered essential for the recovery of the marbled murrelet within Conservation Zones 4, 5 and 6 are: 1) any suitable habitat managed by the Federal government in LSRs located in the Forest Ecosystem Management Assessment Team Zone 1 (see pages IV-23 and IV-24 in U.S. Department of Agriculture *et al.* 1993 for a description of this Zone 1), 4) other large areas of suitable habitat on Federal lands outside of LSRs, 3) large areas of suitable habitat on state lands within 25 miles (40 km) of the coast in California and Oregon, 4) suitable habitat on county park lands within 25 miles (40 km) of the coast in San Mateo and Santa Cruz Counties, California, 5) suitable nesting habitat on Pacific Lumber Company (now Humboldt Redwood Company) lands in Humboldt County, California (Service 1997).

Marine areas in California considered essential for recovery of the marbled murrelet include: 1) nearshore waters (within 1.2 miles of the shore) along the Pacific Coast from the Oregon-California border south to Cape Mendocino in northern California, including Humboldt and Arcata Bays, and river mouths; and 2) nearshore waters (within 1.2 miles of shore) along the Pacific Coast in central California from San Pedro Point south to the mouth of the Pajaro River (Service 1997).

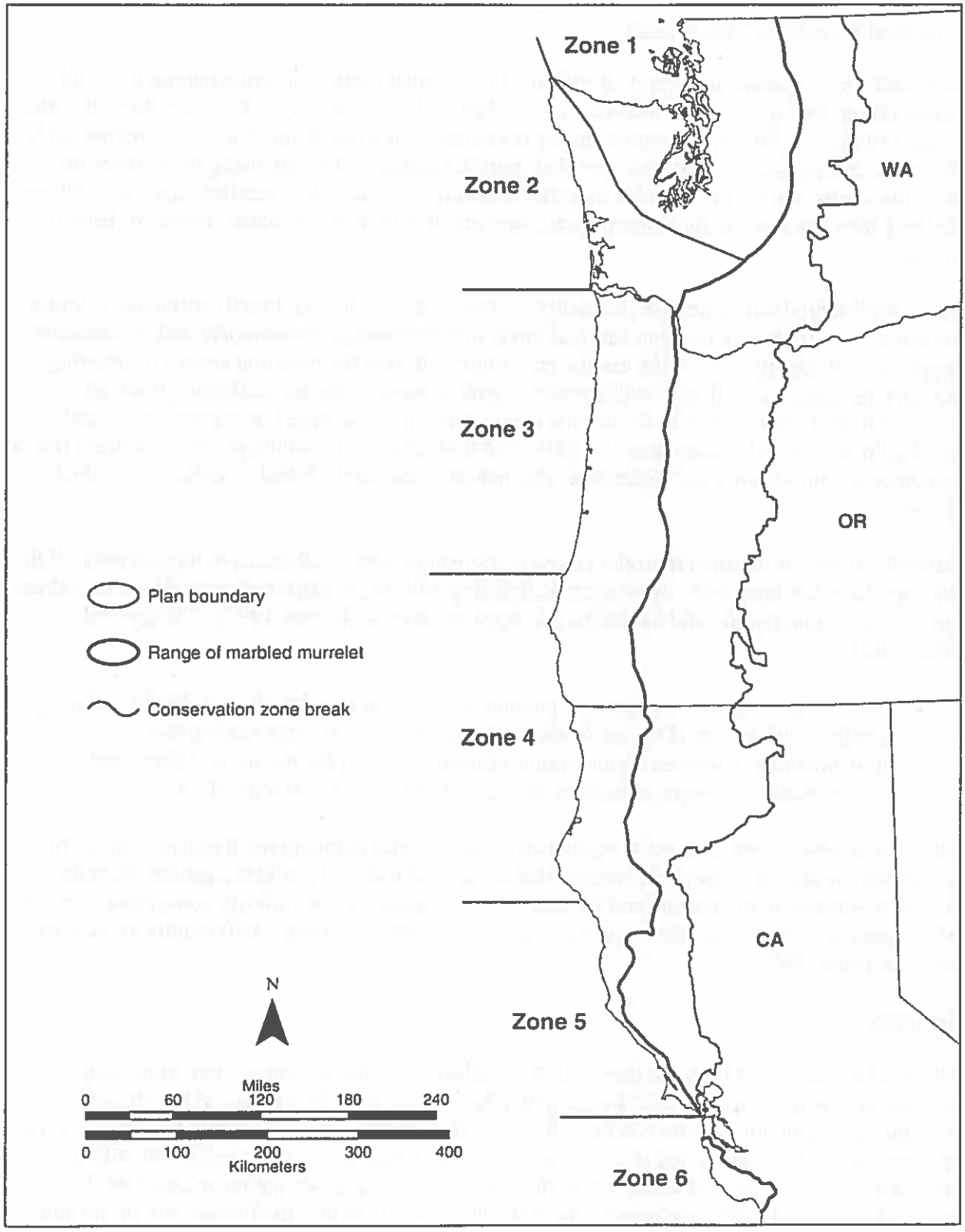


Figure 1. The six geographic areas identified as Conservation Zones in the recovery plan for the marbled murrelet (Service 1997). Note: "Plan boundary" refers to the Northwest Forest Plan. Figure adapted from Huff *et al.* (2006).

Conservation Needs of the Species

Reestablishing an abundant supply of high quality marbled murrelet nesting habitat is a vital conservation need given the extensive removal during the 20th century. However, there are other conservation imperatives. Foremost among the conservation needs are those in the marine and terrestrial environments to increase marbled murrelet fecundity by increasing the number of breeding adults, improving marbled murrelet nest success (due to low nestling survival and low fledging rates), and reducing anthropogenic stressors that reduce individual fitness[4] or lead to mortality.

The overall reproductive success (fecundity) of marbled murrelets is directly influenced by nest predation rates (reducing nestling survival rates) in the terrestrial environment and an abundant supply of high quality prey in the marine environment during the breeding season (improving potential nestling survival and fledging rates). Anthropogenic stressors affecting marbled murrelet fitness and survival in the marine environment are associated with commercial and tribal gillnets, derelict fishing gear, oil spills, and high underwater sound pressure (energy) levels generated by pile-driving and underwater detonations (that can be lethal or reduce individual fitness).

General criteria for marbled murrelet recovery (delisting) were established at the inception of the Plan and have not been met. More specific delisting criteria are expected in the future to address population, demographic, and habitat based recovery criteria (Service 1997). The general criteria include:

- documenting stable or increasing population trends in population size, density, and productivity in four of the six Conservation Zones for a 10-year period, and
- implementing management and monitoring strategies in the marine and terrestrial environments to ensure protection of marbled murrelets for at least 50 years.

Thus, increasing marbled murrelet reproductive success and reducing the frequency, magnitude, or duration of any anthropogenic stressor that directly or indirectly affects marbled murrelet fitness or survival in the marine and terrestrial environments are the priority conservation needs of the species. The Service estimates recovery of the marbled murrelet will require at least 50 years (Service 1997).

Summary

The level of risk posed by some threats to the marbled murrelet population may have been reduced as a result of the species' listing under the Act, such as the passage of the Oil Pollution Act and implementation of the NWFP. However, the Service is not aware that any threats have been removed since listing and in some portions of the listed range, new threats (identified above) have been identified which affect the species at the local population or listed-entity scales. Currently, the Service expects these threats to continue into the foreseeable future and

[4] Fitness is measure of the relative capability of individuals within a species to reproduce and pass its' genotype to the next generation.

those that cause direct mortality or reduce individual fitness are likely to contribute to marbled murrelet population declines.

Considering the life history characteristics of the marbled murrelet, the species' capability to recover from the mortality or reduced-fitness stressors is extremely low. The low observed reproductive rate causes the marbled murrelet population to be highly sensitive to mortality and fitness-reducing stressors, particularly when they occur at a frequency which exceeds the species' loss-replacement rate. Despite the relatively long life span of marbled murrelets and a reasonably high adult survival rate, the annual replacement rates needed for long-term population maintenance and stability is currently well below the annual rate of individuals being removed from each Conservation Zone.

Therefore, given the interactive effect of an extremely low fecundity and the current threats facing the species, it is reasonable to predict that the marbled murrelet populations (in each Conservation Zone) throughout the listed range are likely to continue to decline. The decline is expected to continue until marbled murrelet fecundity is significantly improved and the anthropogenic stressors affecting fitness, survivorship, and nest success are eliminated or sufficiently reduced.

Range-wide Habitat Baseline

The destruction, modification, or curtailment of nesting habitat from logging, urbanization, and land use conversion has generally been regarded as the most influential environmental stressor that led to the 1992 Federal listing of the species under the Act. The Service estimates that over 80 percent of the historical nesting habitat has been rendered unsuitable for nesting (57 FR 45328). Because of the important role nesting habitat plays in the survival and recovery of the species, significant attention has been given to describing the quality, quantity, and location of the remaining nesting habitat and planning for the restoration of nesting habitat in California, Oregon, and Washington.

Loss of Nesting Habitat Since 1992

The Service has determined that the rate of habitat loss has declined since listing, particularly on Federal lands due to implementation of the NWFP (Service 2004). Between 1992 and 2003, the estimated loss of suitable marbled murrelet habitat totaled 22,398 acres in Washington, Oregon, and California combined, of which 5,364 acres resulted from timber harvest and 17,034 acres resulted from natural events (McShane *et al.* 2004). Those data primarily represented losses on Federal lands, and did not include data for most private or State lands within the marbled murrelet's range. Table 3 reports all acres of murrelet habitat consulted on by the Service between 2003 and October 26, 2016.

More recent data on habitat losses, and from all ownerships, comes from the NWFP Effectiveness Monitoring (EM) Program. They used spatial habitat models to estimate distribution and losses of potential suitable marbled murrelet nesting habitat during the period from 1994-1996 to 2006-2007 on both Federal and non-Federal lands within the five Conservation Zones in the NWFP area (Raphael *et al.* 2011). Results indicate that losses of

potential nesting habitat have been greater than previously estimated, with losses ranging from 270,000 to 490,000 acres of higher-suitability habitat in the 5-Conservation Zone area (amount of loss depends on the method of calculating losses, as discussed below and in Raphael *et al.* 2011). Of this habitat loss, about 72,000 to 77,000 acres (16 to 26 percent) occurred on Federal lands and about 200,000 to 414,000 acres (74 to 84 percent) on non-Federal lands. Fire was the primary cause of loss (74 percent) on Federal lands during this period, followed by harvest (20 percent, about 15,300 acres), while harvest caused most loss (95 percent) on non-Federal lands (Raphael *et al.* 2011). Most of the fire loss on Federal lands was associated with the 2002 Biscuit Fire in southwestern Oregon.

Current Amount of Nesting Habitat

McShane *et al.* (2004), reviewed and summarized habitat estimates from 16 sources and estimated the amount of marbled murrelet nesting habitat at 2,223,048 acres distributed throughout Washington, Oregon, and California (McShane *et al.* 2004). Washington State contains almost half of all remaining nesting habitat with an estimated 1,022,695 acres or 48 percent of the total. Approximately 93 percent (2,000,000 acres) are reported to occur on Federal lands (McShane *et al.* 2004).

Recently, Raphael *et al.* (2011) used models to predict the amount, location, and distribution of potentially suitable marbled murrelet nesting habitat. Their habitat model used the Maximum Entropy (Maxent) methodology (Phillips and Dudik 2008) to compare vegetation and physical attributes for known marbled murrelet occupied polygons or nest locations with conditions over the entire range of forested lands in which marbled murrelets occurred. The resulting habitat maps ranked suitability as nesting habitat throughout the entire range, relative to conditions at those known nest locations and occupied sites. Separate models and maps were developed for each state for a baseline year of 1994-1996, and resulted in maps of habitat suitability broken into four classes, ranging from lowest (Class 1) to highest (Class 4) suitability nesting habitat, each with acreage estimates. In Washington, 2.3 million acres of habitat were classified as "higher suitability" (Classes 3 plus 4), of which 1.0 million acres were in the "highest suitability" class (Class 4). In Oregon, 1.4 million acres of habitat were classified as higher suitability, of which 0.6 million acres were Class 4. In California, about 133,000 acres of habitat were rated as higher suitability, of which about 51,000 acres of habitat were Class 4.

The above estimates are for the baseline period of 1994 (California) or 1996 (Oregon and Washington). Raphael *et al.* (2011) also provide more estimates of habitat, based on projecting the same Maxent habitat suitability models onto maps with vegetation conditions in 2006-2007. They also used separate LandTrendr spatial data on vegetation change (Kennedy *et al.* 2010) to refine the estimates of habitat loss as determined by the model projections. This helped identify likely causes of habitat loss, and provided estimates of suitable nesting habitat in 2006-2007. As detailed in Raphael *et al.* (2011), they used two methods to estimate habitat in those years, resulting in two estimates. The estimated amount of higher-suitability habitat (Class 3 plus 4) for Washington in 2006 is 2.05 to 2.1 million acres, for Oregon in 2006 is 1.15 to 1.31 million acres, and for California in 2007 is 124,000 to 130,000 acres.

The Service believes the Raphael *et al.* (2011) models, which use characteristics of known (occupied) marbled murrelet nest stands to estimate habitat abundance, distribution, and quality, represent the best available information on the subject. While not necessarily the best means to describe suitable habitat at the site scale, the Service expects these models have higher reliability for state or provincial-scale analysis compared to previous efforts.

Table 3: Aggregate Results of All Suitable Habitat (Acres) Affected by Section 7 Consultation for the Marbled Murrelet; Summary of Effects By Conservation Zone and Habitat Type From October 1st, 2003 to October 26, 2016.

Conservation Zone[1]	Authorized Habitat Effects[2]		Reported Habitat Effects[2]	
	Stands[3]	Remnants[4]	Stands[3]	Remnants[4]
Puget Sound	-105	0	-1	0
Western Washington	-12	0	-12	0
Outside CZ Area in WA	0	0	0	0
Oregon Coast Range	-2,584	-930	-2,145	0
Siskiyou Coast Range	-2,858	0	-1	0
Outside CZ Area in OR	-1	0	0	0
Mendocino	0	0	0	0
Santa Cruz Mountains	0	0	0	0
Outside CZ Area in CA	0	0	0	0
Total	**-5,560**	**-930**	**-2,159**	**0**

Notes:

1. Conservation Zones (CZ) six zones were established by the 1997 Recovery Plan to guide terrestrial and marine management planning and monitoring for the Marbled Murrelet. *Marbled Murrelet Recovery Plan, September, 1997*
2. Habitat includes all known occupied sites, as well as other suitable habitat, though it is not necessarily occupied. Importantly, there is no single definition of suitable habitat, though the Marbled Murrelet Effectiveness Monitoring Module is in the process. Some useable working definitions include the Primary Constituent Elements as defined in the Critical Habitat Final Rule, or the criteria used for Washington State by Raphael *et al.* (2002).
3. Stand: A patch of older forest in an area with potential platform trees.
4. Remnants: A residual/remnant stand is an area with scattered potential platform trees within a younger forest that lacks, overall, the structures for marbled murrelet nesting.

Status of the Species – Northern Spotted Owl

Legal Status

The northern spotted owl (*Strix occidentalis caurina*) was listed as threatened on June 26, 1990, due to widespread loss and adverse modification of suitable habitat across the owl's entire range and the inadequacy of existing regulatory mechanisms to conserve the owl (Service 1990a, p. 26114). The northern spotted owl was originally listed with a recovery priority number of 3C, but that number was changed to 6C in 2004 during the 5-year review of the species (Service 2004b, p. 55). Priority numbers are assigned on a scale of 1C (highest) to 18 (lowest). This number reflects a high degree of threat, a low potential for recovery, and the owl's taxonomic status as a subspecies (Service 1983b, p. 51895). The "C" reflects conflict with development, construction, or other economic activity (Service 1983a, p. 43104). The most recent 5-year status review was completed on September 29, 2011, and did not propose changes to the listing status or introduce any new threats (Service 2011b).

Life History

Taxonomy

The northern spotted owl is one of three subspecies of spotted owls currently recognized by the American Ornithologists' Union. The taxonomic separation of these three subspecies is supported by genetic (Barrowclough and Gutiérrez 1990, pp.741-742; Barrowclough *et al.* 1999, p. 928; Haig *et al.* 2004, p. 1354), morphological (Gutiérrez *et al.* 1995, p. 2), and biogeographic information (Barrowclough and Gutiérrez 1990, p.741-742). The distribution of the Mexican subspecies (*S. o. lucida*) is separate from those of the northern and California (*S. o. occidentalis*) subspecies (Gutiérrez *et al.* 1995, p.2). Recent studies analyzing mitochondrial DNA sequences (Haig *et al.* 2004, p. 1354; Chi *et al.* 2004, p. 3; Barrowclough *et al.* 2005, p. 1117) and microsatellites (Henke *et al.*, unpubl. data, p. 15) confirmed the validity of the current subspecies designations for northern and California spotted owls. The narrow hybrid zone between these two subspecies, which is located in the southern Cascades and northern Sierra Nevada, appears to be stable (Barrowclough *et al.* 2005, p. 1116).

Funk *et al.* (2008, pp. 1-11) tested the validity of the three current recognized subspecies of spotted owls and found them to be valid. During this genetics study, bi-directional hybridization and dispersal between northern spotted owls and California spotted owls centered in southern Oregon and northern California was discovered. In addition, a discovery of introregression of Mexican spotted owls into the northernmost parts of the northern spotted owl populations in Washington was made, indicating long-distance dispersal of Mexican spotted owls into the northern spotted owl range (Funk *et al.* 2008, pp. 1-11). Some hybridization of northern spotted owls with barred owls has been recorded (Hamer *et al.* 1994, pp. 487-491; Dark *et al.* 1998, pp. 50-56; Kelly 2001, pp. 33, 38).

Physical Description

The northern spotted owl is a medium-sized owl and is the largest of the three subspecies of spotted owls (Gutiérrez *et al.* 1995, p. 2). It is approximately 46 to 48 centimeters (18 inches to 19 inches) long and the sexes are dimorphic, with males averaging about 13 percent smaller than

females. The mean mass of 971 males taken during 1,108 captures was 580.4 grams (1.28 pounds) (out of a range 430.0 to 690.0 grams) (0.95 pound to 1.52 pounds), and the mean mass of 874 females taken during 1,016 captures was 664.5 grams (1.46 pounds) (out of a range 490.0 to 885.0 grams) (1.1 pounds to 1.95 pounds) (P. Loschl and E. Forsman, pers. comm. cited in Service 2011b, p. A-1). The northern spotted owl is dark brown with a barred tail and white spots on its head and breast, and it has dark brown eyes surrounded by prominent facial disks. Four age classes can be distinguished on the basis of plumage characteristics (Forsman 1981; Moen *et al.* 1991, p. 493). The northern spotted owl superficially resembles the barred owl, a species with which it occasionally hybridizes (Kelly and Forsman 2004, p. 807). Hybrids exhibit physical and vocal characteristics of both species (Hamer *et al.* 1994, p. 488).

Current and Historical Range

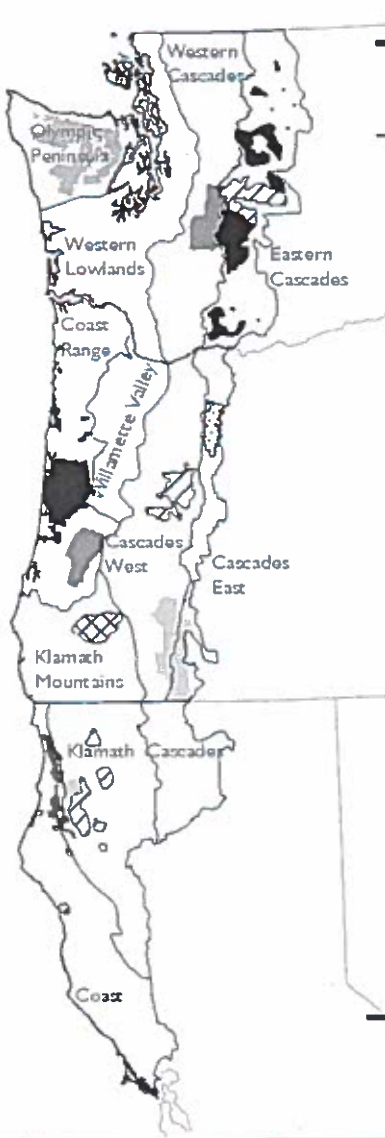
The current range of the spotted owl extends from southwest British Columbia through the Cascade Mountains, coastal ranges, and intervening forested lands in Washington, Oregon, and California, as far south as Marin County (Service 1990a, p. 26115). The range of the spotted owl is partitioned into 12 physiographic provinces (see Figure 1) based on recognized landscape subdivisions exhibiting different physical and environmental features (Service 2011b, p. III-1; Thomas *et al.* 1993). These provinces are distributed across the species' range as follows:

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

The spotted owl is extirpated or uncommon in certain areas such as southwestern Washington and British Columbia. Timber harvest activities have eliminated, reduced or fragmented spotted owl habitat sufficiently to decrease overall population densities across its range, particularly within the coastal provinces where habitat reduction has been concentrated (Service 2011b, pp. B-1 to B-4; Thomas and Raphael 1993)

Behavior

Northern spotted owls are primarily nocturnal (Forsman *et al.* 1984, pp. 51-52) and spend virtually their entire lives beneath the forest canopy (Courtney *et al.* 2004, p. 2-5). They are adapted to maneuverability beneath the forest canopy rather than strong, sustained flight (Gutiérrez *et al.* 1995, p. 9). They forage between dusk and dawn and sleep during the day with peak activity occurring during the two hours after sunset and the two hours prior to sunrise (Gutiérrez *et al.* 1995, p. 5; Delaney *et al.* 1999, p. 44). They will sometimes take advantage of vulnerable prey near their roosts during the day (Layman 1991, pp. 138-140; Sovern *et al.* 1994, p. 202).



Demographic Study Area	Land Ownership	# Owls Banded	Fecundity	Apparent Survival	λ_{RUS}	Population Trend Based on $\Delta\lambda$
Washington						
Wenatchee (WEN)	Private	1,200	Stable	Declining	0.917	Declining
Rainer (RAI)	USFS	217	Stable	Declining	0.896	Declining
Olympic (OLY)	NPS & USFS	985	Stable	Declining	0.956	Declining
Cle Elum (CLE)	USFS	724	Declining[1]	Declining?[2]	0.938	Declining
Oregon						
Oregon Coast Range (COA)	USFS & BLM	1,025	Declining?[1]	Stable	0.968	Declining
Tyee (TYE)	BLM & Private	1,032	Increasing	Stable	1.005	Stationary
South Oregon Cascades (CAS)	USFS & BLM	881	Declining	Stable	0.974	Stationary
H.J. Andrews (HJA)	USFS	1,095	Stable?[3]	Stable	0.978	Declining
Klamath (KLA)	BLM & Private	1,147	Stable	Stable	0.997	Stationary
Warm Springs (WSR)	Tribal	381	Stable	Stable	0.908	Declining
California						
Marin (MAR)	NPS	96	Stable	Stable	NA	NA
Simpson (SIM)	Private	1,344	Declining[1]	Stable	0.970	Declining
Hoopa (HUP)	Tribal	279	Increasing	Stable	0.980	Stationary
NW California (NWC)	USFS	1,026	Declining	Declining	0.985	Declining?[4]

[1] Best model included age and even-odd year effects, but a competing model had a negative time effect on productivity.
[2] Variable among years, but with a declining trend.
[3] Decreasing in early years, increase in last 5 years, stable overall.
[4] Gradual declines in fecundity and apparent survival, plus estimates of realized population change suggest a decline in last 8 years.

Figure 1. Physiographic provinces, northern spotted owl demographic study areas, and demographic trends (Anthony *et al*. 2006).

Northern spotted owls seek sheltered roosts to avoid inclement weather, summer heat, and predation (Forsman 1975, pp. 105-106; Barrows and Barrows 1978; Barrows 1981; Forsman *et al.* 1984, pp. 29-30). Northern spotted owls become stressed at temperatures above 28°C, but there is no evidence to indicate that they have been directly killed by temperature because of their ability to thermoregulate by seeking out shady roosts in the forest understory on hot days (Barrows and Barrows 1978; Forsman *et al.* 1984, pp. 29-30, 54; Weathers *et al.* 2001, pp. 678, 684). During warm weather, spotted owls seek roosts in shady recesses of understory trees and occasionally will even roost on the ground (Barrows and Barrows 1978, pp. 3, 7-8; Barrows 1981, pp. 302-306, 308; Forsman *et al.* 1984, pp. 29-30, 54; Gutiérrez *et al.* 1995, p. 7). Glenn *et al.* (2010, p. 2549) found that population growth was negatively associated with hot summer temperatures at their southernmost study area in the southern Oregon Cascades, indicating that warm temperatures may still have an effect on the species. Both adults and juveniles have been observed drinking water, primarily during the summer, which is thought to be associated with thermoregulation (Gutiérrez *et al.* 1995, p. 7).

Spotted owls are territorial; however, home ranges of adjacent pairs overlap (Forsman *et al.* 1984, p. 22; Solis and Gutiérrez 1990, p. 746) suggesting that the area defended is smaller than the area used for foraging. They will actively defend their nests and young from predators (Forsman 1975, p. 15; Gutiérrez *et al.* 1995, p. 11). Territorial defense is primarily effected by hooting, barking and whistle type calls. Some spotted owls are not territorial but either remain as residents within the territory of a pair or move among territories (Gutiérrez 1996, p. 4). These birds are referred to as "floaters." Floaters have special significance in spotted owl populations because they may buffer the territorial population from decline (Franklin 1992, p. 822). Little is known about floaters other than that they exist and typically do not respond to calls as vigorously as territorial birds (Gutiérrez 1996, p. 4).

Spotted owls are monogamous and usually form long-term pair bonds. "Divorces" occur but are relatively uncommon. There are no known examples of polygyny in this owl, although associations of three or more birds have been reported (Gutiérrez *et al.* 1995, p. 10).

Habitat Relationships

Home Range

Home-range sizes vary geographically, generally increasing from south to north, which is likely a response to differences in habitat quality (Service 1990a, p. 26117). Estimates of median size of their annual home range (the area traversed by an individual or pair during their normal activities (Thomas and Raphael 1993, pp. IX-15)) vary by province and range from 2,955 acres in the Oregon Cascades (Thomas *et al.* 1990, p. 194) to 14,211 acres on the Olympic Peninsula (Service 1994a, p. 3). Zabel *et al.* (1995, p. 436) showed that these provincial home ranges are larger where flying squirrels are the predominant prey and smaller where wood rats are the predominant prey. Home ranges of adjacent pairs overlap (Forsman *et al.* 1984, p. 22; Solis and Gutiérrez 1990, p. 746), suggesting that the defended area is smaller than the area used for foraging. Within the home range there is a smaller area of concentrated use during the breeding season (approximately 20 percent of the home range), often referred to as the core area (Bingham and Noon 1997, pp. 133-135). Spotted owl core areas vary in size geographically and provide habitat elements that are important for the reproductive efficacy of the territory, such as the nest tree, roost sites and foraging areas (Bingham and Noon 1997, p. 134). Spotted owls use smaller

home ranges during the breeding season and often dramatically increase their home range size during fall and winter (Forsman *et al.* 1984, pp. 21-22; Sisco 1990, p. iii).

Although differences exist in natural stand characteristics that influence home range size, habitat loss and forest fragmentation effectively reduce habitat quality in the home range. A reduction in the amount of suitable habitat reduces spotted owl abundance and nesting success (Bart and Forsman 1992, pp. 98-99; Bart 1995, p. 944).

Habitat Use and Selection

Forsman *et al.* (1984, pp.15-16) reported that spotted owls have been observed in the following forest types: Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), grand fir (*Abies grandis*), white fir (*Abies concolor*), ponderosa pine (*Pinus ponderosa*), Shasta red fir (*Abies magnifica shastensis*), mixed evergreen, mixed conifer hardwood (Klamath montane), and redwood (*Sequoia sempervirens*). The upper elevation limit at which spotted owls occur corresponds to the transition to subalpine forest, which is characterized by relatively simple structure and severe winter weather (Forsman 1975, p. 27; Forsman *et al.* 1984, pp. 15-16).

Spotted owls generally rely on older forested habitats because such forests contain the structures and characteristics required for nesting, roosting, and foraging. 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 (Thomas *et al.* 1990, p. 19). Forested stands with high canopy closure also provide thermal cover (Weathers *et al.* 2001, p. 686) and protection from predators (Franklin *et al.* 2000, p. 578).

Spotted owls nest almost exclusively in trees. Like roosts, nest sites are found in forests having complex structure dominated by large diameter trees (Forsman *et al.* 1984, p. 30; Hershey *et al.* 1998, p. 1402). Even in forests that have been previously logged, spotted owls select forests having a structure (i.e., larger trees, greater canopy closure) different than forests generally available to them (Folliard 1993, p. 40; Buchanan *et al.* 1995, p. 1402; Hershey *et al.* 1998, p. 1404).

Roost sites selected by spotted owls have more complex vegetation structure than forests generally available to them (Barrows and Barrows 1978, p. 3; Forsman *et al.* 1984, pp. 29-30; Solis and Gutiérrez 1990, pp. 742-743). These habitats are usually multi-layered forests having high canopy closure and large diameter trees in the overstory.

Foraging habitat is the most variable of all habitats used by territorial spotted owls (Thomas *et al.* 1990; Service 2011b, p. G-2). Descriptions of foraging habitat have ranged from complex structure (Solis and Gutiérrez 1990, pp. 742-744) to forests with lower canopy closure and smaller trees than forests containing nests or roosts (Gutiérrez 1996, p. 5). Foraging habitat for northern spotted owls provides a food supply for survival and reproduction. Foraging activity is positively associated with tree height diversity (North *et al.* 1999, p. 524), canopy closure (Irwin

et al. 2000, p. 180; Courtney *et al.* 2004, pp. 5-15), snag volume, density of snags greater than 20 in (50 cm) dbh (North *et al.* 1999, p. 524; Irwin *et al.* 2000, pp. 179-180; Courtney *et al.* 2004, pp. 5-15), density of trees greater than or equal to 31 in (80 cm) dbh (North *et al.* 1999, p. 524), volume of woody debris (Irwin *et al.* 2000, pp. 179-180), and young forests with some structural characteristics of old forests (Carey *et al.*1992, pp. 245-247; Irwin *et al.* 2000, pp. 178-179). Northern spotted owls select old forests for foraging in greater proportion than their availability at the landscape scale (Carey *et al.* 1992, pp. 236-237; Carey and Peeler 1995, p. 235; Forsman *et al.* 2004, pp. 372-373), but will forage in younger stands with high prey densities and access to prey (Carey *et al.* 1992, p. 247; Rosenberg and Anthony 1992, p. 165; Thome *et al.* 1999, pp. 56-57).

Dispersal habitat is essential to maintaining stable populations by filling territorial vacancies when resident northern spotted owls die or leave their territories, and to providing adequate gene flow across the range of the species. Dispersal habitat, at a minimum, consists of stands with adequate tree size and canopy closure to provide protection from avian predators and at least minimal foraging opportunities (Service 2011b, p. G-1). Dispersal habitat may include younger and less diverse forest stands than foraging habitat, such as even-aged, pole-sized stands, but such stands should contain some roosting structures and foraging habitat to allow for temporary resting and feeding for dispersing juveniles (Service 2011b, p. G-1). Forsman *et al.* (2002, p. 22) found that spotted owls could disperse through highly fragmented forest landscapes. However, the stand-level and landscape-level attributes of forests needed to facilitate successful dispersal have not been thoroughly evaluated (Buchanan 2004, p. 1341).

Spotted owls may be found in younger forest stands that have the structural characteristics of older forests or retained structural elements from the previous forest. In redwood forests and mixed conifer-hardwood forests along the coast of northwestern California, considerable numbers of spotted owls also occur in younger forest stands, particularly in areas where hardwoods provide a multi-layered structure at an early age (Thomas *et al.* 1990, p. 158; Diller and Thome 1999, p. 275). In mixed conifer forests in the eastern Cascades in Washington, 27 percent of nest sites were in old-growth forests, 57 percent were in the understory reinitiation phase of stand development, and 17 percent were in the stem exclusion phase (Buchanan *et al.* 1995, p. 304). In the western Cascades of Oregon, 50 percent of spotted owl nests were in late-seral/old-growth stands (greater than 80 years old), and none were found in stands of less than 40 years old (Irwin *et al.* 2000, p. 41).

In the Western Washington Cascades, spotted owls roosted in mature forests dominated by trees greater than 50 centimeters (19.7 inches) dbh with greater than 60 percent canopy closure more often than expected for roosting during the non-breeding season. Spotted owls also used young forest (trees of 20 to 50 centimeters (7.9 inches to 19.7 inches) dbh with greater than 60 percent canopy closure) less often than expected based on this habitat's availability (Herter *et al.* 2002, p. 437).

In the Coast Ranges, Western Oregon Cascades and the Olympic Peninsula, radio-marked spotted owls selected for old-growth and mature forests for foraging and roosting and used young forests less than predicted based on availability (Forsman *et al.* 1984, pp. 24-25; Carey *et al.* 1990, pp. 14-15; Thomas *et al.* 1990; Forsman *et al.* 2005, pp. 372-373). Glenn *et al.* (2004,

pp. 46-47) studied spotted owls in young forests in western Oregon and found little preference among age classes of young forest. In the California Klamath Province, northern spotted owls were found nesting and roosting at sites with greater amounts of mature and old-growth forest than were found at random sites (Hunter *et al.* 1995).

Habitat use is influenced by prey availability. Ward (1990, p. 62) found that spotted owls foraged in areas with lower variance in prey densities (that is, where the occurrence of prey was more predictable) within older forests and near ecotones of old forest and brush seral stages. Zabel *et al.* (1995, p. 436) showed that spotted owl home ranges are larger where flying squirrels (*Glaucomys sabrinus*) are the predominant prey and smaller where wood rats (*Neotoma* spp.) are the predominant prey.

Recent landscape-level analyses in portions of Oregon Coast and California Klamath provinces suggest that a mosaic of late-successional habitat interspersed with other seral conditions may benefit spotted owls more than large, homogeneous expanses of older forests (Zabel *et al.* 2003, p. 1038; Franklin *et al.* 2000, pp. 573-579; Meyer *et al.* 1998, p. 43). In Oregon Klamath and Western Oregon Cascade provinces, Dugger *et al.* (2005, p. 876) found that apparent survival and reproduction was positively associated with the proportion of older forest near the territory center (within 730 meters) (2,395 feet). Survival decreased dramatically when the amount of non-habitat (non-forest areas, sapling stands, etc.) exceeded approximately 50 percent of the home range (Dugger *et al.* 2005, pp. 873-874). The authors concluded that they found no support for either a positive or negative direct effect of intermediate-aged forest—that is, all forest stages between sapling and mature, with total canopy cover greater than 40 percent—on either the survival or reproduction of spotted owls. It is unknown how these results were affected by the low habitat fitness potential in their study area, which Dugger *et al.* (2005, p. 876) stated was generally much lower than those in Franklin *et al.* (2000) and Olson *et al.* (2004), and the low reproductive rate and survival in their study area, which they reported were generally lower than those studied by Anthony *et al.* (2006). Olson *et al.* (2004, pp. 1050-1051) found that reproductive rates fluctuated biennially and were positively related to the amount of edge between late-seral and mid-seral forests and other habitat classes in the central Oregon Coast Range. Olson *et al.* (2004, pp. 1049-1050) concluded that their results indicate that while mid-seral and late-seral forests are important to spotted owls, a mixture of these forest types with younger forest and non-forest may be best for spotted owl survival and reproduction in their study area. In a large-scale demography modeling study, Forsman *et al.* (2011, pp. 1-2) found a positive correlation between the amount of suitable habitat and recruitment of young.

Reproductive Biology

The spotted owl is relatively long-lived, has a long reproductive life span, invests significantly in parental care, and exhibits high adult survivorship relative to other North American owls (Forsman *et al.* 1984; Gutiérrez *et al.* 1995, p. 5). Spotted owls are sexually mature at 1 year of age, but rarely breed until they are 2 to 5 years of age (Miller *et al.* 1985, p. 93; Franklin 1992, p. 821; Forsman *et al.* 2002, p. 17). Breeding females lay one to four eggs per clutch, with the average clutch size being two eggs; however, most spotted owl pairs do not nest every year, nor are nesting pairs successful every year (Service 1990b; Forsman *et al.* 1984, pp. 32-34; Anthony *et al.* 2006, p. 28), and renesting after a failed nesting attempt is rare (Gutiérrez 1996, p. 4). The

small clutch size, temporal variability in nesting success, and delayed onset of breeding all contribute to the relatively low fecundity of this species (Gutiérrez 1996, p. 4).

Courtship behavior usually begins in February or March, and females typically lay eggs in late March or April. The timing of nesting and fledging varies with latitude and elevation (Forsman *et al.* 1984, p. 32). After they leave the nest in late May or June, juvenile spotted owls depend on their parents until they are able to fly and hunt on their own. Parental care continues after fledging into September (Service 1990a; Forsman *et al.* 1984, p. 38). During the first few weeks after the young leave the nest, the adults often roost with them during the day. By late summer, the adults are rarely found roosting with their young and usually only visit the juveniles to feed them at night (Forsman *et al.* 1984, p. 38). Telemetry and genetic studies indicate that close inbreeding between siblings or parents and their offspring is rare (Haig *et al.* 2001, p. 35; Forsman *et al.* 2002, p. 18). Hybridization of northern spotted owls with California spotted owls and barred owls has been confirmed through genetic research (Hamer *et al.* 1994, pp. 487-492; Gutiérrez *et al.* 1995, pp. 2-3; Dark *et al.* 1998, p. 52; Kelly 2001, pp. 33-35; Funk *et al.* 2008, pp. 161-171).

Dispersal Biology

Natal dispersal of spotted owls typically occurs in September and October with a few individuals dispersing in November and December (Miller *et al.* 1997; Forsman *et al.* 2002, p. 13). Natal dispersal occurs in stages, with juveniles settling in temporary home ranges between bouts of dispersal (Forsman *et al.* 2002, pp. 13-14; Miller *et al.* 1997, p. 143). The median natal dispersal distance is about 10 miles for males and 15.5 miles for females (Forsman *et al.* 2002, p. 16). Dispersing juvenile spotted owls experience high mortality rates, exceeding 70 percent in some studies (Service 1990a; Miller 1989, pp. 32-41). Known or suspected causes of mortality during dispersal include starvation, predation, and accidents (Miller 1989, pp. 41-44; Service 1990a; Forsman *et al.* 2002, pp. 18-19). Parasitic infection may contribute to these causes of mortality, but the relationship between parasite loads and survival is poorly understood (Hoberg *et al.* 1989, p. 247; Gutiérrez 1989, pp. 616-617; Forsman *et al.* 2002, pp. 18-19). Successful dispersal of juvenile spotted owls may depend on their ability to locate unoccupied suitable habitat in close proximity to other occupied sites (LaHaye *et al.* 2001, pp. 697-698).

There is little evidence that small openings in forest habitat influence the dispersal of spotted owls, but large, non-forested valleys such as the Willamette Valley apparently are barriers to both natal and breeding dispersal (Forsman *et al.* 2002, p. 22). The degree to which water bodies, such as the Columbia River and Puget Sound, function as barriers to dispersal is unclear, although radio telemetry data indicate that spotted owls move around large water bodies rather than cross them (Forsman *et al.* 2002, p. 22). Analysis of the genetic structure of spotted owl populations suggests that gene flow may have been adequate between the Olympic Mountains and the Washington Cascades, and between the Olympic Mountains and the Oregon Coast Range (Haig *et al.* 2001, p. 35).

Breeding dispersal occurs among a small proportion of adult spotted owls; these movements were more frequent among females and unmated individuals (Forsman *et al.* 2002, pp. 20-21). Breeding dispersal distances were shorter than natal dispersal distances and also are apparently random in direction (Forsman *et al.* 2002, pp. 21-22). In California spotted owls, a similar

subspecies, the probability for dispersal was higher in younger owls, single owls, paired owls that lost mates, owls at low quality sites, and owls that failed to reproduce in the preceding year (Blakesley *et al.* 2006, p.77). Both males and females dispersed at near equal distances (Blakesley *et al.* 2006, p. 76). In 72 percent of observed cases of dispersal, dispersal resulted in increased habitat quality (Blakesley *et al.* 2006, p. 77).

Dispersal can also be described as having two phases: transience and colonization (Courtney *et al* 2004, p. 5-13). Fragmented forest landscapes are more likely to be used by owls in the transience phase as a means to move rapidly between denser forest areas (Courtney *et al* 2004, p. 5-13; Service 2012, p. 14086). Movements through mature and old growth forests occur during the colonization phase when birds are looking to become established in an area (Miller *et al* 1997, p. 144; Courtney *et al* 2004, p. 5-13). Transient dispersers use a wider variety of forest conditions for movements than colonizing dispersers, who require habitats resembling nesting/roosting/foraging habitats used by breeding birds (Service 2012, p. 14086). Dispersal success is likely highest in mature and old growth forest stands where there is more likely to be adequate cover and food supply (Service 2012, p. 14086).

Food Habits

Spotted owls are mostly nocturnal, although they also forage opportunistically during the day (Forsman *et al.* 1984, p. 51; 2004, pp. 222-223; Sovern *et al.* 1994, p. 202). The composition of the spotted owl's diet varies geographically and by forest type. Generally, flying squirrels (*Glaucomys sabrinus*) are the most prominent prey for spotted owls in Douglas-fir and western hemlock (*Tsuga heterophylla*) forests (Forsman *et al.* 1984, pp. 40-41) in Washington and Oregon, while dusky-footed wood rats (*Neotoma fuscipes*) are a major part of the diet in the Oregon Klamath, California Klamath, and California Coastal provinces (Forsman *et al.* 1984, pp. 40-42; 2004, p. 218; Ward *et al.* 1998, p. 84; Hamer *et al.* 2001, p. 224). Depending on location, other important prey include deer mice (*Peromyscus maniculatus*), tree voles (*Arborimus longicaudus, A. pomo*), red-backed voles (*Clethrionomys* spp.), gophers (*Thomomys* spp.), snowshoe hare (*Lepus americanus*), bushy-tailed wood rats (*Neotoma cinerea*), birds, and insects, although these species comprise a small portion of the spotted owl diet (Forsman *et al.* 1984, pp. 40-43; 2004, p. 218; Ward *et al.* 1998; p. 84; Hamer *et al.* 2001, p.224).

Other prey species such as the red tree vole (*Arborimus longicaudus),* red-backed voles (*Clethrionomys gapperi),* mice, rabbits and hares, birds, and insects) may be seasonally or locally important (reviewed by Courtney *et al.* 2004, pp. 4-27). For example, Rosenberg *et al.* (2003, p. 1720) showed a strong correlation between annual reproductive success of spotted owls (number of young per territory) and abundance of deer mice (*Peromyscus maniculatus*) (r2 = 0.68), despite the fact they only made up 1.6±0.5 percent of the biomass consumed. However, it is unclear if the causative factor behind this correlation was prey abundance or a synergistic response to weather (Rosenberg *et al.* 2003, p. 1723). Ward (1990, p. 55) also noted that mice were more abundant in areas selected for foraging by owls. Nonetheless, spotted owls deliver larger prey to the nest and eat smaller food items to reduce foraging energy costs; therefore, the importance of smaller prey items, like *Peromyscus*, in the spotted owl diet should not be underestimated (Forsman *et al.* 2001, p. 148; 2004, pp. 218-219). In the southern portion of their range, where woodrats are a major component of their diet, northern spotted owls are more likely to use a variety of stands, including younger stands, brushy openings in older stands, and edges

between forest types in response to higher prey density in some of these areas (Forsman *et al.* 1984, pp. 24-29).

Population Dynamics

The spotted owl is relatively long-lived, has a long reproductive life span, invests significantly in parental care, and exhibits high adult survivorship relative to other North American owls (Forsman *et al.* 1984; Gutiérrez *et al.* 1995, p. 5). The spotted owl's long reproductive life span allows for some eventual recruitment of offspring, even if recruitment does not occur each year (Franklin *et al.* 2000, p. 576).

Annual variation in population parameters for spotted owls has been linked to environmental influences at various life history stages (Franklin *et al.* 2000, p. 581). In coniferous forests, mean fledgling production of the California spotted owl (*Strix occidentalis occidentalis*), a closely related subspecies, was higher when minimum spring temperatures were higher (North *et al.* 2000, p. 805), a relationship that may be a function of increased prey availability. Across their range, spotted owls have previously shown an unexplained pattern of alternating years of high and low reproduction, with highest reproduction occurring during even-numbered years (e.g., Franklin *et al.* 1999, p. 1). Annual variation in breeding may be related to weather (i.e., temperature and precipitation) (Wagner *et al.* 1996, p. 74; Zabel *et al.* 1996, p.81 *In*: Forsman *et al.* 1996) and fluctuation in prey abundance (Zabel *et al.* 1996, pp.437-438).

A variety of factors may regulate spotted owl population levels. These factors may be density-dependent (e.g., habitat quality, habitat abundance) or density-independent (e.g., climate). Interactions may occur among factors. For example, as habitat quality decreases, density-independent factors may have more influence on survival and reproduction, which tends to increase variation in the rate of growth (Franklin *et al.* 2000, pp. 581-582). Specifically, weather could have increased negative effects on spotted owl fitness for those owls occurring in relatively lower quality habitat (Franklin *et al.* 2000, pp. 581-582). A consequence of this pattern is that at some point, lower habitat quality may cause the population to be unregulated (have negative growth) and decline to extinction (Franklin *et al.* 2000, p. 583).

Olson *et al.* (2005, pp. 930-931) used open population modeling of site occupancy that incorporated imperfect and variable detectability of spotted owls and allowed modeling of temporal variation in site occupancy, extinction, and colonization probabilities (at the site scale). The authors found that visit detection probabilities average less than 0.70 and were highly variable among study years and among their three study areas in Oregon. Pair site occupancy probabilities declined greatly on one study area and slightly on the other two areas. However, for all owls, including singles and pairs, site occupancy was mostly stable through time. Barred owl presence had a negative effect on these parameters (see barred owl discussion in the New Threats section below). However, there was enough temporal and spatial variability in detection rates to indicate that more visits would be needed in some years and in some areas, especially if establishing pair occupancy was the primary goal.

Threats

Reasons for Listing

The spotted owl was listed as threatened throughout its range "due to loss and adverse modification of suitable habitat as a result of timber harvesting and exacerbated by catastrophic events such as fire, volcanic eruption, and wind storms" (Service 1990a, p. 26114). More specifically, threats to the spotted owl included low populations, declining populations, limited habitat, declining habitat, inadequate distribution of habitat or populations, isolation of provinces, predation and competition, lack of coordinated conservation measures, and vulnerability to natural disturbance (Service 1992a, pp. 33-41). These threats were characterized for each province as severe, moderate, low, or unknown (Service 1992a, pp. 33-41). Declining habitat was recognized as a severe or moderate threat to the spotted owl throughout its range, isolation of populations was identified as a severe or moderate threat in 11 provinces, and a decline in population was a severe or moderate threat in 10 provinces. Together, these three factors represented the greatest concerns about range-wide conservation of the spotted owl. Limited habitat was considered a severe or moderate threat in nine provinces, and low populations were a severe or moderate concern in eight provinces, suggesting that these factors were also a concern throughout the majority of the spotted owl's range. Vulnerability to natural disturbances was rated as low in five provinces.

The degree to which predation and competition might pose a threat to the spotted owl was unknown in more provinces than any of the other threats, indicating a need for additional information. Few empirical studies exist to confirm that habitat fragmentation contributes to increased levels of predation on spotted owls (Courtney *et al.* 2004, pp. 11-8 to 11-9). However, great horned owls (*Bubo virginianus*), an effective predator on spotted owls, are closely associated with fragmented forests, openings, and clearcuts (Johnson 1992, p. 84; Laidig and Dobkin 1995, p. 155). As mature forests are harvested, great horned owls may colonize fragmented forests, thereby increasing spotted owl vulnerability to predation.

New Threats

The Service conducted a 5-year review of the spotted owl in 1994 (Service 2004a), for which the Service prepared a scientific evaluation of the status of the spotted owl (Courtney *et al.* 2004). An analysis was conducted assessing how the threats described in 1990 might have changed by 2004. Some of the key threats identified in 2004 are:

- "Although we are certain that current harvest effects are reduced, and that past harvest is also probably having a reduced effect now as compared to 1990, we are still unable to fully evaluate the current levels of threat posed by harvest because of the potential for lag effects…In their questionnaire responses…6 of 8 panel member identified past habitat loss due to timber harvest as a current threat, but only 4 viewed current harvest as a present threat" (Courtney and Gutiérrez 2004, pp.11-7).
- "Currently the primary source of habitat loss is catastrophic wildfire, although the total amount of habitat affected by wildfires has been small (a total of 2.3 percent of the range-wide habitat base over a 10-year period)" (Courtney and Gutiérrez 2004, pp.11-8).
- "Although the panel had strong differences of opinion on the conclusiveness of some of the

> evidence suggesting [barred owl] displacement of [spotted owls], and the mechanisms by which this might be occurring, there was no disagreement that [barred owls] represented an operational threat. In the questionnaire, all 8 panel members identified [barred owls] as a current threat, and also expressed concern about future trends in [barred owl] populations" (Courtney and Gutiérrez 2004, pp. 11-8).

Threats, as identified in the 2011 Revised Recovery Plan for the Northern Spotted Owl, continue to emphasize that habitat loss and barred owls are the main threats to northern spotted owl recovery (Service 2011b).

Barred Owls (Strix varia)

With its recent expansion to as far south as Marin County, California (Gutiérrez *et al.* 2004, pp. 7-12 to 7-13; Steger *et al.* 2006, p.106), the barred owl's range now completely overlaps that of the northern spotted owl. The Service assumes that barred owls inhabit all forested areas within the range of the northern spotted owl where nesting opportunities exist (Service 2011b). Barred owls may be competing with spotted owls for prey (Hamer *et al.* 2001, p.226) or habitat (Hamer *et al.* 1989, p.55; Dunbar *et al.* 1991, p. 467; Herter and Hicks 2000, p. 285; Pearson and Livezey 2003, p. 274). In addition, barred owls physically attack spotted owls (Pearson and Livezey 2003, p. 274), and circumstantial evidence strongly indicated that a barred owl killed a spotted owl (Leskiw and Gutiérrez 1998, p. 226). Evidence that barred owls are causing negative effects on spotted owls is largely indirect, based primarily on retrospective examination of long-term data collected on spotted owls (Kelly *et al.* 2003, p. 46; Pearson and Livezey 2003, p. 267; Olson *et al.* 2005, p. 921). Recent research has shown that the two species of owls share similar habitats and are likely competing for food resources (Hamer *et al.* 2001, p. 226). Research on barred owls and their interactions with northern spotted owls is lacking, but necessary to determine the specific effects barred owls may have on northern spotted owls and their habitat. Forsman *et al.* (2011, pp. 69-70) found that the presence of barred owls led to a decrease in fecundity, apparent survival, and caused a decline in populations in most of the demography study areas included in their large scale modeling effort. However, given that the presence of barred owls has been identified as a negative effect while using methods designed to detect a different species (spotted owls), it seems safe to presume that the effects are stronger than estimated. Because there has been no research to evaluate quantitatively the strength of different types of competitive interactions, such as resource partitioning and competitive interference, the particular mechanism by which the two owl species may be competing is unknown.

Barred owls, though they are generalists, likely compete with northern spotted owls for prey resources (Hamer *et al.* 2001, p. 226; Gutiérrez *et al.* 2007, p. 187; Livezey and Fleming 2007, p. 319). The only study comparing northern spotted owl and barred owl food habits in the Pacific Northwest indicated that barred owl diets overlap strongly (76 percent) with northern spotted owl diets (Hamer *et al.* 2001, pp. 221, 226). Barred owl diets are more diverse than northern spotted owl diets and include species associated with riparian and other moist habitats (e.g. fish, invertebrates, frogs, and crayfish), along with more terrestrial and diurnal species (Smith *et al.* 1983; Hamer *et al.* 2001; Gronau 2005). Even though barred owls may be taking northern spotted owls' primary prey only as a generalist, northern spotted owls may be affected by a sufficient reduction in the density of these prey items due to barred owls, leading to a depletion of prey to the extent that the northern spotted owl cannot find an adequate amount of food to

sustain maintenance or reproduction (Gutiérrez *et al.* 2007, p. 187; Livezey and Fleming 2007, p. 319).

Barred owls were initially thought to be more closely associated with early successional forests than spotted owls, based on studies conducted on the west slope of the Cascades in Washington (Hamer *et al* 1989, p. 34; Iverson 1993, p.39). However, recent studies conducted in the Pacific Northwest show that barred owls frequently use mature and old-growth forests (Pearson and Livezey 2003, p. 270; Gremel 2005, Schmidt 2006, p. 1; Singleton *et al.* 2010, pp. 290-292). In the fire prone forests of eastern Washington, a telemetry study conducted on barred owls showed that barred owl home ranges were located on lower slopes or valley bottoms, in closed canopy, mature, Douglas-fir forest, while spotted owl sites were located on mid-elevation areas with southern or western exposure, characterized by closed canopy, mature, ponderosa pine or Douglas-fir forest (Singleton *et al.* 2005, p. 1).

The presence of barred owls has been reported to reduce spotted owl detectability, site occupancy, reproduction, and survival. Olson *et al.* (2005, p. 924) found that the presence of barred owls had a significant negative effect on the detectability of spotted owls, and that the magnitude of this effect did not vary among years. The occupancy of historical territories by spotted owls in Washington and Oregon was significantly lower ($p < 0.001$) after barred owls were detected within 0.8 kilometer (0.5 miles) of the territory center but was "only marginally lower" ($p = 0.06$) if barred owls were located more than 0.8 kilometer (0.5 miles) from the spotted owl territory center (Kelly *et al.* 2003, p. 51). Pearson and Livezey (2003, p. 271) found that there were significantly more barred owl site-centers in unoccupied spotted owl circles than occupied spotted owl circles (centered on historical spotted owl site-centers) with radii of 0.8 kilometer (0.5 miles) ($p = 0.001$), 1.6 kilometer (1 mile) ($p = 0.049$), and 2.9 kilometer (1.8 miles) ($p = 0.005$) in Gifford Pinchot National Forest. In Olympic National Park, Gremel (2005, p. 11) found a significant decline ($p = 0.01$) in spotted owl pair occupancy at sites where barred owls had been detected, while pair occupancy remained stable at spotted owl sites without barred owls. Olson *et al.* (2005, p. 928) found that the annual probability that a spotted owl territory would be occupied by a pair of spotted owls after barred owls were detected at the site declined by 5 percent in the HJ Andrews study area, 12 percent in the Coast Range study area, and 15 percent in the Tyee study area. In contrast, Bailey *et al.* (2009, p. 2983), when using a two-species occupancy model, showed no evidence that barred owls excluded northern spotted owls from territories in Oregon. Most recently, preliminary results from a barred owl and northern spotted owl radio-telemetry study in Washington reported two northern spotted owls fleeing their territories and traveling six and 15 miles, believed to be as a result of frequent direct encounters with barred owls (Irwin *et al.* 2010, pp. 3-4). Both northern spotted owls were subsequently found dead (Irwin *et al.* 2010, p. 4).

Olson *et al.* (2004, p. 1048) found that the presence of barred owls had a significant negative effect on the reproduction of spotted owls in the central Coast Range of Oregon (in the Roseburg study area). The conclusion that barred owls had no significant effect on the reproduction of spotted owls in one study (Iverson 2004, p. 89) was unfounded because of small sample sizes (Livezey 2005, p. 102). It is likely that all of the above analyses underestimated the effects of barred owls on the reproduction of spotted owls because spotted owls often cannot be relocated after they are displaced by barred owls (E. Forsman, pers. comm., cited in Service 2011a, p. B-11). Anthony *et al.* (2006, p. 32) found significant evidence of negative effects of barred owls on

survival of spotted owls in two of 14 study areas (Olympic and Wenatchee). They attributed the equivocal results for most of their study areas to the coarse nature of their barred owl covariate. Dugger *et al.* (2011, pp. 2463-2467) confirmed the synergistic effects of barred owls and territory habitat characteristics on extinction and colonization rates of territories by northern spotted owls. Extinction rates of northern spotted owl territories nearly tripled when barred owls were detected (Dugger *et al.* 2011, p. 2464).

Monitoring and management of northern spotted owls has become more complicated due to their possible reduced detectability when barred owls are present (Kelly *et al.* 2003, pp. 51-52; Courtney *et al.* 2004, p. 7-16 ; Olson *et al.* 2005, p. 929; Crozier *et al.* 2006, p.766-767). Evidence that northern spotted owls were responding less frequently during surveys led the Service and its many research partners to update the northern spotted owl survey protocol. The recent changes to the northern spotted owl survey protocol were based on the probability of detecting northern spotted owls when barred owls are present (See USDI FWS Memorandum dated February 7, 2011, "2011 Northern Spotted Owl Survey Protocol" and attached "Protocol for Surveying Proposed Management Activities That May Impact Northern Spotted Owls" for guidance and methodology).

In a recent analysis of more than 9,000 banded spotted owls throughout their range, only 47 hybrids were detected (Kelly and Forsman 2004, p. 807). Consequently, hybridization with the barred owl is considered to be "an interesting biological phenomenon that is probably inconsequential, compared with the real threat—direct competition between the two species for food and space" (Kelly and Forsman 2004, p. 808).

Evidence suggests that barred owls are exacerbating the spotted owl population decline, particularly in Washington, portions of Oregon, and the northern coast of California (Gutiérrez *et al.* 2004, pp. 739-740; Olson *et al.* 2005, pp. 930-931). There is no evidence that the increasing trend in barred owls has stabilized in any portion of the spotted owl's range in the western United States, and "there are no grounds for optimistic views suggesting that barred owl impacts on northern spotted owls have been already fully realized" (Gutiérrez *et al.* 2004, pp. 7-38). In Oregon, Dugger *et al.* (2011, p. 2466) reported that some northern spotted owl pairs retained their territories and continued to survive and successfully reproduce during their study even when barred owls were present, but that the effects of reduced old growth forest in the core habitat areas were compounded when barred owls were present.

Wildfire

Studies indicate that the effects of wildfire on spotted owls and their habitat are variable, depending on fire intensity, severity, and size. Within the fire-adapted forests of the spotted owl's range, spotted owls likely have adapted to withstand fires of variable sizes and severities. However, fire is often considered a primary threat to spotted owls because of its potential to alter habitat rapidly (Bond *et al.* 2009, p. 1116) and is a major cause of habitat loss on Federal lands (Courtney *et al.* 2004, executive summary). Bond *et al.* (2002, p. 1025) examined the demography of the three spotted owl subspecies after wildfires, in which wildfire burned through spotted owl nest and roost sites in varying degrees of severity. Post-fire demography parameters for the three subspecies were similar or better than long-term demographic parameters for each of the three subspecies in those same areas (Bond *et al.* 2002, p. 1026). In a preliminary study

conducted by Anthony and Andrews (2004, p. 8) in the Oregon Klamath Province, their sample of spotted owls appeared to be using a variety of habitats within the area of the Timbered Rock fire, including areas where burning had been moderate.

In 1994, the Hatchery Complex fire burned 17,603 hectares in the Wenatchee National Forest in Washington's eastern Cascades, affecting six spotted owl activity centers (Gaines *et al.* 1997, p. 125). Spotted owl habitat within a 2.9-kilometer (1.8-mile) radius of the activity centers was reduced by 8 to 45 percent (mean = 31 percent) as a result of the direct effects of the fire and by 10 to 85 percent (mean = 55 percent) as a result of delayed mortality of fire-damaged trees and insects. Direct mortality of spotted owls was assumed to have occurred at one site, and spotted owls were present at only one of the six sites 1 year after the fire (Gaines *et al.* 1997, p. 126). In 1994, two wildfires burned in the Yakama Indian Reservation in Washington's eastern Cascades, affecting the home ranges of two radio-tagged spotted owls (King *et al.* 1998, pp. 2-3). Although the amount of home ranges burned was not quantified, spotted owls were observed using areas that burned at low and medium intensities. No direct mortality of spotted owls was observed, even though thick smoke covered several spotted owl site-centers for a week. It appears that, at least in the short term, spotted owls may be resilient to the effects of wildfire—a process with which they have evolved. More research is needed to understand further the relationship between fire and spotted owl habitat use. Overall, we can conclude that fires are a change agent for northern spotted owl habitat, but there are still many unknowns regarding how much fire benefits or adversely affects northern spotted owl habitat (Service 2011a, p. III-31).

At the time of listing there was recognition that large-scale wildfire posed a threat to the spotted owl and its habitat (Service 1990a, p. 26183). New information suggests fire may be more of a threat than previously thought. In particular, the rate of habitat loss in the relatively dry East Cascades and Klamath provinces has been greater than expected (see "Habitat Trends" below). Moeur *et al.* (2005, p. 110) suggested that 12 percent of late-successional forest rangewide would likely be negatively impacted by wildfire during the first 5 decades of the Northwest Forest Plan. Currently, the overall total amount of habitat affected by wildfires has been relatively small (Lint 2005, p. v). It may be possible to influence through silvicultural management how fire prone forests will burn and the extent of the fire when it occurs. Silvicultural management of forest fuels are currently being implemented throughout the spotted owl's range, in an attempt to reduce the levels of fuels that have accumulated during nearly 100 years of effective fire suppression. However, our ability to protect spotted owl habitat and viable populations of spotted owls from large fires through risk-reduction endeavors is uncertain (Courtney *et al.* 2004, pp. 12-11). The NWFP recognized wildfire as an inherent part of managing spotted owl habitat in certain portions of the range. The distribution and size of reserve blocks as part of the NWFP design may help mitigate the risks associated with large-scale fire (Lint 2005, p. 77).

West Nile Virus

West Nile virus (WNV), caused by a virus in the family Flaviviridae, has killed millions of wild birds in North America since it arrived in 1999 (McLean *et al.* 2001; Caffrey 2003; Caffrey and Peterson 2003, pp. 7-8; Marra *et al.* 2004, p. 393). Mosquitoes are the primary carriers (vectors) of the virus that causes encephalitis in humans, horses, and birds. Mammalian prey may also play a role in spreading WNV among predators, like spotted owls. Owls and other predators of mice

can contract the disease by eating infected prey (Garmendia *et al.* 2000, p. 3111; Komar *et al.* 2001). One captive spotted owl in Ontario, Canada, is known to have contracted WNV and died.

Health officials expect that WNV will eventually spread throughout the range of the spotted owl (Courtney *et al.* 2004; Blakesley *et al.* 2004, pp. 8-31), but it is unknown how WNV will ultimately affect spotted owl populations. Susceptibility to infection and the mortality rates of infected individuals vary among bird species (Blakesley *et al.* 2004, pp. 8-33), but most owls appear to be quite susceptible. For example, breeding Eastern screech owls (*Megascops asio*) in Ohio experienced 100 percent mortality (T. Grubb pers. comm. in Blakesley *et al.* 2004, pp. 8-33). Barred owls, in contrast, showed lower susceptibility (B. Hunter pers. comm. in Blakesley *et al.* 2004, pp. 8-34). Some level of innate resistance may occur (Fitzgerald *et al.* 2003), which could explain observations in several species of markedly lower mortality in the second year of exposure to WNV (Caffrey and Peterson 2003). Wild birds also develop resistance to WNV through immune responses (Deubel *et al.* 2001). The effects of WNV on bird populations at a regional scale have not been large, even for susceptible species (Caffrey and Peterson 2003), perhaps due to the short-term and patchy distribution of mortality (K. McGowan, pers. comm., cited in Courtney *et al.* 2004) or annual changes in vector abundance and distribution.

Blakesley *et al.* (2004, pp. 8-35) offer competing propositions for the likely outcome of spotted owl populations being infected by WNV. One scenario is that spotted owls can tolerate severe, short-term population reductions due to WNV, because spotted owl populations are widely distributed and number in the several hundreds to thousands. An alternative scenario is that WNV will cause unsustainable mortality, due to the frequency and/or magnitude of infection, thereby resulting in long-term population declines and extirpation from parts of the spotted owl's current range. Thus far, no mortality in wild, northern spotted owls has been recorded; however, WNV is a potential threat of uncertain magnitude and effect (Blakesley *et al.* 2004, pp. 8-34).

Sudden Oak Death

Sudden oak death was recently identified as a potential threat to the spotted owl (Courtney *et al.* 2004). This disease is caused by the fungus-like pathogen, *Phytopthora ramorum* that was recently introduced from Europe and is rapidly spreading. The disease is now known to extend over 650 km from south of Big Sur, California to Curry County, Oregon (Rizzo and Garbelotto 2003, p. 198), and has reached epidemic proportions in oak (Quercus spp.) and tanoak (*Lithocarpus densiflorus*) forests along approximately 300 kilometers of the central and northern California coast (Rizzo *et al.* 2002, p. 733). At the present time, sudden oak death is found in natural stands from Monterey to Humboldt Counties, California, and has reached epidemic proportions in oak (*Quercus* spp.) and tanoak (*Lithocarpus densiflorus*) forests along approximately 300 km of the central and northern California coast (Rizzo *et al.* 2002, p. 733). It has also been found near Brookings, Oregon, killing tanoak and causing dieback of closely associated wild rhododendron (*Rhododendron* spp.) and evergreen huckleberry (*Vaccinium ovatum*) (Goheen *et al.* 2002, p. 441). It has been found in several different forest types and at elevations from sea level to over 800 m. During a study completed between 2001 and 2003 in California, one-third to one-half of the hiker's present in the study area carried infected soil on their shoes (Davidson *et al.* 2005, p. 587), creating the potential for rapid spread of the disease. Sudden oak death poses a threat of uncertain proportion because of its potential impact on forest dynamics and alteration of key prey and spotted owl habitat components (e.g., hardwood trees -

canopy closure and nest tree mortality); especially in the southern portion of the spotted owl's range (Courtney *et al.* 2004, pp. 11-8).

Inbreeding Depression, Genetic Isolation, and Reduced Genetic Diversity

Inbreeding and other genetic problems due to small population sizes were not considered an imminent threat to the spotted owl at the time of listing. Recent studies show no indication of reduced genetic variation and past bottlenecks in Washington, Oregon, or California (Barrowclough *et al.* 1999, p. 922; Haig *et al.* 2004, p. 36). Canadian populations may be more adversely affected by issues related to small population size including inbreeding depression, genetic isolation, and reduced genetic diversity (Courtney *et al.* 2004, pp. 11-9). A 2004 study (Harestad *et al.* 2004, p. 13) indicates that the Canadian breeding population was estimated to be less than 33 pairs and annual population decline may be as high as 35 percent. In 2007, a recommendation was made by the Spotted Owl Population Enhancement Team to remove northern spotted owls from the wild in British Columbia (Service 2012, p. 14078). This recommendation resulted in the eventual capture of the remaining 16 wild northern spotted owls in British Columbia for a captive breeding program (Service 2012, p. 14078). Low and persistently declining populations throughout the northern portion of the species range (see "Population Trends" below) may be at increased risk of losing genetic diversity. Hybridization of northern spotted owls with California spotted owls, Mexican spotted owls, and barred owls has been confirmed through genetic research (Funk *et al.* 2008, p. 1; Hamer *et al.* 1994, p. 487; Gutiérrez *et al.* 1995, p. 3; Dark *et al.* 1998, p. 50; Kelly 2001, pp. 33-35).

Climate Change

Climate change, combined with effects from past management practices is influencing current forest ecosystem processes and dynamics by increasing the frequency and magnitude of wildfires, insect outbreaks, drought, and disease (USFWS 2011b, pp. III-5 - III-11). In the Pacific Northwest, mean annual temperatures rose 0.8° C (1.5° F) in the 20th century and are expected to continue to warm from 0.1° to 0.6° C (0.2° to 1° F) per decade (Mote and Salathe 2010, p. 29). Climate change models generally predict warmer, wetter winters and hotter, drier summers and increased frequency of extreme weather events in the Pacific Northwest (Salathe *et al.* 2010, pp. 72-73).

Predicted climate changes in the Pacific Northwest have implications for forest disturbances that affect the quality and distribution of spotted owl habitat. Both the frequency and intensity of wildfires and insect outbreaks are expected to increase over the next century in the Pacific Northwest (Littell *et al.* 2010, p. 130). One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration, and severity. Westerling *et al.* (2006, pp. 940-941) analyzed wildfires and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period from 1970-1986. The total area burned is more than 6.5 times the previous level and the average length of the fire season during 1987-2003 was 78 days longer compared to 1978-1986 (Westerling *et al.* 2006, p. 941). The area burned annually by wildfires in the Pacific Northwest is expected to double or triple by the 2080s (Littell *et al.* 2010, p. 140). Wildfires are now the primary cause of spotted owl habitat loss on Federal lands, with over 236,000 acres of habitat loss attributed to wildfires from 1994 to 2007 (Davis *et al.* 2011, p. 123).

Potential changes in temperature and precipitation have important implications for spotted owl reproduction and survival. Wet, cold weather during the winter or nesting season, particularly the early nesting season, has been shown to negatively affect spotted owl reproduction (Olson *et al.* 2004, p. 1039, Dugger *et al.* 2005, p. 863), survival (Franklin *et al.* 2000 pp. 576-577, Olson *et al.* 2004, p. 1039, Glenn *et al.* 2011, p. 1279), and recruitment (Glenn *et al.* 2010, pp.2446-2547). Cold, wet weather may reduce reproduction and/or survival during the breeding season due to declines or decreased activity in small mammal populations so that less food is available during reproduction when metabolic demands are high (Glenn *et al.* 2011, pp. 1288-1289). Cold, wet nesting seasons may increase the mortality of nestlings due to chilling and reduce the number of young fledged per pair per year (Franklin *et al.* 2000, p.557, Glenn *et al.* 2011, p. 1286).

Drought or hot temperatures during the summer have also been linked to reduced spotted owl recruitment (Glenn *et al.* 2010, p. 2549). Drier, warmer summers and drought conditions during the growing season strongly influence primary production in forests, food availability, and the population sizes of small mammals that spotted owls prey upon (Glenn *et al.* 2010, p. 2549).

In summary, climate change is likely to exacerbate some existing threats to the spotted owl such as the projected potential for increased habitat loss from drought-related fire, tree mortality, insects and disease, as well as affecting reproduction and survival during years of extreme weather.

Disturbance

Northern spotted owls may also respond physiologically to a disturbance without exhibiting a significant behavioral response. In response to environmental stressors, vertebrates secrete stress hormones called corticosteroids (Campbell 1990, p. 925). Although these hormones are essential for survival, extended periods with elevated stress hormone levels may have negative effects on reproductive function, disease resistance, or physical condition (Carsia and Harvey 2000, pp. 517-518; Sapolsky *et al.* 2000, p. 1). In avian species, the secretion of corticosterone is the primary non-specific stress response (Carsia and Harvey 2000, p. 517). The quantity of this hormone in feces can be used as a measure of physiological stress (Wasser *et al.* 1997, p. 1019). Recent studies of fecal corticosterone levels of northern spotted owls indicate that low intensity noise of short duration and minimal repetition does not elicit a physiological stress response (Tempel and Gutiérrez 2003, p. 698; Tempel and Gutiérrez 2004, p. 538). However, prolonged activities, such as those associated with timber harvest, may increase fecal corticosterone levels depending on their proximity to northern spotted owl core areas (Wasser *et al.* 1997, p.1021; Tempel and Gutiérrez 2004, p. 544).

The effects of noise on spotted owls are largely unknown, and whether noise is a concern has been a controversial issue. The effect of noise on birds is extremely difficult to determine due to the inability of most studies to quantify one or more of the following variables: 1) timing of the disturbance in relation to nesting chronology; 2) type, frequency, and proximity of human disturbance; 3) clutch size; 4) health of individual birds; 5) food supply; and 6) outcome of previous interactions between birds and humans (Knight and Skagan 1988, pp. 355-358). Additional factors that confound the issue of disturbance include the individual bird's tolerance

level, ambient sound levels, physical parameters of sound, and how it reacts with topographic characteristics and vegetation, and differences in how species perceive noise.
Information specific to behavioral responses of spotted owls to disturbance is limited, research indicates that recreational activity can cause Mexican spotted owls (*S. o. lucida*) to vacate otherwise suitable habitat (Swarthout and Steidl 2001, p. 314) and helicopter overflights can reduce prey delivery rates to nests (Delaney *et al.* 1999, p. 70). Additional effects from disturbance, including altered foraging behavior and decreases in nest attendance and reproductive success, have been reported for other raptors (White and Thurow 1985, p. 14; Andersen *et al.* 1989, p. 296; McGarigal *et al.* 1991, p. 5).
Although it has not been conclusively demonstrated, it is anticipated that nesting spotted owls may be disturbed by heat and smoke as a result of burning activities during the breeding season.

Conservation Needs of the Spotted Owl

Based on the above assessment of threats, the spotted owl has the following habitat-specific and habitat-independent conservation (i.e., survival and recovery) needs:

Habitat-specific Needs

1. Large blocks of habitat capable of supporting clusters or local population centers of spotted owls (e.g., 15 to 20 breeding pairs) throughout the owl's range;

2. Suitable habitat conditions and spacing between local spotted owl populations throughout its range that facilitate survival and movement;

3. Suitable habitat distributed across a variety of ecological conditions within the northern spotted owl's range to reduce risk of local or widespread extirpation;

4. A coordinated, adaptive management effort to reduce the loss of habitat due to catastrophic wildfire throughout the spotted owl's range, and a monitoring program to clarify whether these risk reduction methods are effective and to determine how owls use habitat treated to reduce fuels; and

5. In areas of significant population decline, sustain the full range of survival and recovery options for this species in light of significant uncertainty.

Habitat-independent Needs

1. A coordinated research and adaptive management effort to better understand and manage competitive interactions between spotted and barred owls; and

2. Monitoring to understand better the risk that WNV and sudden oak death pose to spotted owls and, for WNV, research into methods that may reduce the likelihood or severity of outbreaks in spotted owl populations.

Conservation Strategy

Since 1990, various efforts have addressed the conservation needs of the spotted owl and attempted to formulate conservation strategies based upon these needs. These efforts began with

the ISC's Conservation Strategy (Thomas *et al.* 1990); they continued with the designation of critical habitat (Service 1992a), the Draft Recovery Plan (Service 1992b), and the Scientific Analysis Team report (Thomas *et al.* 1993), report of the Forest Ecosystem Management Assessment Team (Thomas and Raphael 1993); and they culminated with the NWFP (USFS and BLM 1994a). Each conservation strategy was based upon the reserve design principles first articulated in the ISC's report, which are summarized as follows:

- Species that are well distributed across their range are less prone to extinction than species confined to small portions of their range.
- Large blocks of habitat, containing multiple pairs of the species, are superior to small blocks of habitat with only one to a few pairs.
- Blocks of habitat that are close together are better than blocks far apart.
- Habitat that occurs in contiguous blocks is better than habitat that is more fragmented.
- Habitat between blocks is more effective as dispersal habitat if it resembles suitable habitat.

Federal Contribution to Recovery

Since it was signed on April 13, 1994, the NWFP has guided the management of Federal forest lands within the range of the spotted owl (USFS and BLM 1994a, 1994b). The NWFP was designed to protect large blocks of old growth forest and provide habitat for species that depend on those forests including the spotted owl, as well as to produce a predictable and sustainable level of timber sales. The NWFP included land use allocations which would provide for population clusters of northern spotted owls (i.e., demographic support) and maintain connectivity between population clusters. Certain land use allocations in the plan contribute to supporting population clusters: LSRs, Managed Late-successional Areas, and Congressionally Reserved areas. Riparian Reserves, Adaptive Management Areas, and Administratively Withdrawn areas can provide both demographic support and connectivity/dispersal between the larger blocks, but were not necessarily designed for that purpose. Matrix areas were to support timber production while also retaining biological legacy components important to old-growth obligate species (in 100-acre owl cores, 15 percent late-successional provision, etc. (USFS and BLM 1994a, Service 1994b) which would persist into future managed timber stands.

The NWFP with its rangewide system of LSRs was based on work completed by three previous studies (Thomas et. al. 2006): the 1990 Interagency Scientific Committee (ISC) Report (Thomas et. al. 1990), the 1991 report for the Conservation of Late-successional Forests and Aquatic Ecosystems (Johnson et. al. 1991), and the 1993 report of the Scientific Assessment Team (Thomas et. al. 1993). In addition, the 1992 Draft Recovery Plan for the Northern Spotted Owl (Service 1992b) was based on the ISC report.

The Forest Ecosystem Management Assessment Team predicted, based on expert opinion, the spotted owl population would decline in the Matrix land use allocation over time, while the population would stabilize and eventually increase within LSRs as habitat conditions improved over the next 50 to 100 years (Thomas and Raphael 1993, p. II-31; USFS and BLM 1994a, 1994b, p. 3&4-229). Based on the results of the first decade of monitoring, Lint (2005, p. 18)

could not determine whether implementation of the NWFP would reverse the spotted owl's declining population trend because not enough time had passed to provide the necessary measure of certainty. However, the results from the first decade of monitoring do not provide any reason to depart from the objective of habitat maintenance and restoration as described in the NWFP (Lint 2005, p. 18; Noon and Blakesley 2006, p. 288). Bigley and Franklin (2004, pp. 6-34) suggested that more fuels treatments are needed in east-side forests to preclude large-scale losses of habitat to stand-replacing wildfires. Other stressors that occur in suitable habitat, such as the range expansion of the barred owl (already in action) and infection with WNV (which may or may not occur) may complicate the conservation of the spotted owl. Recent reports about the status of the spotted owl offer few management recommendations to deal with these emerging threats. The arrangement, distribution, and resilience of the NWFP land use allocation system may prove to be the most appropriate strategy in responding to these unexpected challenges (Bigley and Franklin 2004, p. 6-34). The Revised Recovery Plan builds on the NWFP and recommends continued implementation of the NWFP and its standards and guides (Service 2011b, p. I-1).

Under the NWFP, the agencies anticipated a decline of spotted owl populations during the first decade of implementation. Recent reports (Courtney *et al.* 2004; Anthony *et al.* 2006, pp. 33-34) identified greater than expected spotted owl declines in Washington and northern portions of Oregon, and more stationary populations in southern Oregon and northern California. The reports did not find a direct correlation between habitat conditions and changes in vital rates of spotted owls at the meta-population scale. However, at the territory scale, there is evidence of negative effects to spotted owl fitness due to reduced habitat quantity and quality. Also, there is no evidence to suggest that dispersal habitat is currently limiting (Courtney *et al.* 2004, p. 9-12; Lint 2005, p. 87). Even with the population decline, Courtney *et al* (2004, p. 9-15) noted that there is little reason to doubt the effectiveness of the core principles underpinning the NWFP conservation strategy.

The current scientific information, including information showing northern spotted owl population declines, indicates that the spotted owl continues to meet the definition of a threatened species (Service 2004, p. 54). That is, populations are still relatively numerous over most of its historical range, which suggests that the threat of extinction is not imminent, and that the subspecies is not endangered; even though, in the northern part of its range population trend estimates are showing a decline.

On June 28, 2011 the Service published the Revised Recovery Plan for the Northern Spotted Owl (Service 2011b). The recovery plan identifies threats from competition with barred owls, ongoing loss of northern spotted owl habitat as a result of timber harvest, loss or modification of northern spotted owl habitat from uncharacteristic wildfire, and loss of amount and distribution of northern spotted owl habitat as a result of past activities and disturbances (Service 2011b, p. II-2 and Appendix B). To address these threats, the current recovery strategy identifies five main steps: 1) development of a range-wide habitat modeling framework; 2) barred owl management; 3) monitoring and research; 4) adaptive management; and 5) habitat conservation and active forest restoration (Service 2011b, p. II-2). The recovery plan lists recovery actions that address each of these items, some of which were retained from the 2008 recovery plan. The Managed Owl Conservation Areas and Conservation Support Areas recommended in the 2008 recovery

plan are not a part of the recovery strategy outlined in the revised recovery plan. The Service completed a range-wide, multi-step habitat modeling process to help evaluate and inform management decisions and critical habitat development (Service 2011b, Appendix C).

The final recovery plan (Service 2011b) recommended implementing a robust monitoring and research program for the spotted owl. The recovery plan encourages these efforts by laying out the following primary elements to evaluate progress toward meeting recovery criteria: monitoring spotted owl population trends, comprehensive barred owl research and monitoring, continued habitat monitoring; inventory of spotted owl distribution, and; explicit consideration for climate change mitigation goals consistent with recovery actions (Service 2011b, p. II-5). The revised recovery plan also strongly encourages land managers to be aggressive in the implementation of recovery actions. In other words, land managers should not be so conservative that, to avoid risk, they forego actions that are necessary to conserve the forest ecosystems that are necessary to the long-term conservation of the spotted owl. But they should also not be so aggressive that they subject spotted owls and their habitat to treatments where the long-term benefits do not clearly outweigh the short-term risks. Finding the appropriate balance to this dichotomy will remain an ongoing challenge for all who are engaged in spotted owl conservation (Service 2011b, p. II-12). The revised recovery plan estimates that recovery of the spotted owl could be achieved in approximately 30 years (Service 2011b, p. II-3).

Conservation Efforts on Non-Federal Lands

In the report from the Interagency Scientific Committee (Thomas *et al.* 1990, p. 3, p. 272), the draft recovery plan (Service 1992b), and the report from the Forest Ecosystem Management Assessment Team (Thomas and Raphael 1993, p. IV-189), it was noted that limited Federal ownership in some areas constrained the ability to form a network of old-forest reserves to meet the conservation needs of the spotted owl. In these areas in particular, non-Federal lands would be important to the range-wide goal of achieving conservation and recovery of the spotted owl. The U.S. Fish and Wildlife Service's primary expectations for private lands are for their contributions to demographic support (pair or cluster protection) to Federal lands, or their connectivity with Federal lands. In addition, timber harvest within each state is governed by rules that provide protection of spotted owls or their habitat to varying degrees.

There are 17 current and ongoing conservation plans (CPs) including Habitat Conservation Plans (HCPs) and Safe Harbor Agreements (SHAs) that have incidental take permits issued for northern spotted owls—eight in Washington, three in Oregon, and six in California (Service 2011b, p. A-15). The CPs range in size from 76 acres to more than 1.8 million acres, although not all acres are included in the mitigation for northern spotted owls. In total, the CPs cover approximately 3 million acres (9.4 percent) of the 32 million acres of non-Federal forest lands in the range of the northern spotted owl. The period of time that the HCPs will be in place ranges from 20 to 100 years. While each CP is unique, there are several general approaches to mitigation of incidental take:

- Reserves of various sizes, some associated with adjacent Federal reserves
- Forest harvest that maintains or develops nesting habitat
- Forest harvest that maintains or develops foraging habitat

- Forest management that maintains or develops dispersal habitat
- Deferral of harvest near specific sites

Washington. In 1996, the State Forest Practices Board adopted rules (Washington Forest Practices Board 1996) that would contribute to conserving the spotted owl and its habitat on non-Federal lands. Adoption of the rules was based in part on recommendations from a Science Advisory Group that identified important non-Federal lands and recommended roles for those lands in spotted owl conservation (Hanson *et al.* 1993, pp. 11-15; Buchanan *et al.* 1994, p. ii). The 1996 rule package was developed by a stakeholder policy group and then reviewed and approved by the Forest Practices Board (Buchanan and Swedeen 2005, p. 9). Spotted owl-related HCPs in Washington generally were intended to provide demographic or connectivity support (Service 1992b, p. 272). There are over 2.1 million acres of land in six HCPs and two SHAs (Service 2011b, p. A-15). Some of these CPs focus on providing nesting/roosting habitat throughout the area or in strategic locations; while others focus on providing connectivity through foraging habitat and/or dispersal habitat. In addition, there is a long term habitat management agreement covering 13,000 acres in which authorization of take was provided through an incidental take statement (section 7) associated with a Federal land exchange (Service 2011b, p. A-15).

Oregon. The Oregon Forest Practices Act provides for protection of 70-acre core areas around sites occupied by an adult pair of spotted owls capable of breeding (as determined by recent protocol surveys), but it does not provide for protection of spotted owl habitat beyond these areas (Oregon Department of Forestry 2007, p. 64). In general, no large-scale spotted owl habitat protection strategy or mechanism currently exists for non-Federal lands in Oregon. The three spotted owl-related HCPs currently in effect cover more than 300,000 acres of non-Federal lands. These HCPs are intended to provide some nesting habitat and connectivity over the next few decades (Service 2011b, p. A-16). On July 27, 2010, the Service completed a programmatic SHA with the Oregon Department of Forestry that will enroll up to 50,000 acres of non-federal lands within the State over 50 years. The primary intent of this programmatic SHA is to increase time between harvests and to lightly to moderately thin younger forest stands that are currently not habitat to increase tree diameter and stand diversity (Service 2011b, p. A-16).

California. The California State Forest Practice Rules, which govern timber harvest on private lands, require surveys for spotted owls in suitable habitat and to provide protection around activity centers (California Department of Forestry and Fire Protection 2007, pp. 85-87). Under the Forest Practice Rules, no timber harvest plan can be approved if it is likely to result in incidental take of federally listed species, unless the take is authorized by a Federal incidental take permit (California Department of Forestry and Fire Protection 2007, pp. 85-87). The California Department of Fish and Game initially reviewed all timber harvest plans to ensure that take was not likely to occur; the U.S. Fish and Wildlife Service took over that review function in 2000. Several large industrial owners operate under spotted owl management plans that have been reviewed by the U.S. Fish and Wildlife Service and that specify basic measures for spotted owl protection. Four HCPs and two SHAs authorizing take of spotted owls have been approved; these HCPs cover more than 622,000 acres of non-Federal lands. Implementation of these plans is intended to provide for spotted owl demographic and connectivity support to NWFP lands (Service 2011b, p. A-16).

Current Condition of the Spotted Owl

The current condition of the species incorporates the effects of all past human activities and natural events that led to the present-day status of the species and its habitat (Service and NMFS 1998, pp. 4-19).

Range-wide Habitat and Population Trends

Range-wide Habitat Baseline

The Service has used information provided by the USFS, BLM, and National Park Service to update the habitat baseline conditions by tracking relative habitat changes over time on Federal lands for northern spotted owls on several occasions, since the northern spotted owl was listed in 1990 (USFS and BLM 1994b, Lint 2005, Davis *et al.* 2011). The estimate of 7.4 million acres used for the NWFP in 1994 (USFS and BLM 1994b) was believed to be representative of the general amount of northern spotted owl habitat on NWFP lands at that time.

The most recent mapping effort (Davis *et al.* 2011, Appendix D, Table D) indicates approximately 8.85 million acres of spotted owl nesting/roosting habitat existed on Federal lands and 4.19 million acres existed on non-federal lands at the beginning of the NWFP in 1994/1996. Davis *et al.* (2011, pp. 28-30) further evaluated changes in spotted owl nesting/roosting habitat using data from California that covered 14 years from 1994 to 2007, and data from Oregon and Washington that covered 10 years from 1996 to 2006. Although the spatial resolution of this new habitat map currently makes it unsuitable for tracking habitat effects at the scale of individual projects, the Service has evaluated the map for use in tracking provincial and range-wide habitat trends and now considers these data as the best available information on the distribution and abundance of extant spotted owl habitat within its range as of 2006 for Oregon and Washington, and 2007 for California, when the base imagery was collected.

Periodic range-wide evaluations of habitat, as compared to the Final Supplemental Environmental Impact Statement (FSEIS; USFS and BLM 1994b), are necessary to determine if the rate of potential change to northern spotted owl habitat is consistent with the change anticipated in the NWFP: a reduction in suitable habitat of approximately 2.5 percent per decade (USFS and BLM 1994a, p. 46). In particular, the Service considers habitat effects that are documented through the section 7 consultation process since 1994. In general, the analytical framework of these consultations focuses on the reserve and connectivity goals established by the NWFP land-use allocations (USFS and BLM 1994a), with effects expressed in terms of changes in suitable northern spotted owl habitat within those land-use allocations.

In 2001, the Service conducted the first assessment of habitat baseline conditions since implementation of the NWFP (Service 2001). The Service determined that actions and effects were consistent with the expectations for implementation of the NWFP from 1994 to June 2001 (Service 2001). April 13, 2004, marked the start of the second decade of the NWFP. Decade-specific baselines and summaries of effects by State, physiographic province and land use function from proposed management activities and natural events are not provided here, but are consistent with expected habitat changes under the NWFP.

In February 2013, the Service adopted the 2006/07 satellite imagery data on spotted owl habitat as the new range-wide habitat baseline for Federal lands which effectively resets the timeframe for establishing changes in the distribution and abundance of spotted owl habitat. On that basis, the assessment of local, provincial and range-wide spotted owl habitat status in this and future Opinions as well as Biological Assessments will rely on these 2006/07 habitat data to characterize changes in the status of spotted owl habitat.

Service's Consultation Database

To update information considered in 2001 (Service 2001), the Service designed the Consultation Effects Tracking System database in 2002, which recorded impacts to northern spotted owls and their habitat at different spatial and temporal scales. In 2011, the Service replaced the Consultation Effects Tracking System with the Consulted on Effects Database located in the Service's Environmental Conservation Online System (ECOS). The ECOS Database corrected technical issues with the Consultation Effects Tracking System. Data are currently entered into the ECOS Database under various categories including; land management agency, land-use allocation, physiographic province, and type of habitat affected.

Range-wide Consultation Effects: 1994 to October 26, 2016

Between 1994 and October 26, 2016, the Service has consulted on the proposed removal/downgrade of approximately 211,669 acres (Table 1) or 2.4 percent of the 8.854 million acres of northern spotted owl nesting/roosting habitat estimated by Davis *et al.* (2011) to have occurred on Federal lands. These changes in suitable northern spotted owl habitat are consistent with the expectations for implementation of the NWFP, which anticipated a rate of habitat harvested at 2.5 percent per decade (USFS and BLM 1994a).

The Service tracks habitat changes on non-NWFP lands through consultations for long-term Habitat Conservation Plans, Safe Harbor Agreements, or Tribal Forest Management Plans. Service consultations conducted since 1992 have documented the eventual loss of over 522,604 acres of habitat on non-NWFP lands. Most of these losses have yet to be realized because they are part of large-scale, long-term Habitat Conservation Plans. However, the NWFP 15 year monitoring report documented habitat losses on non-federal lands associated with timber harvest continues to occur at a rate of approximately 2 percent per year in Oregon and Washington, and at a lesser rate in California (Davis *et al.* 2011, pp. 123-124).

Table 1: Range-wide Aggregate of Changes to NRF[1] Habitat Acres From Activities Subject to Section 7 Consultations and Other Causes (1994 to October 26, 2016).

Land Ownership	Consulted On Habitat Changes[2]		Other Habitat Changes[3]	
	Removed/ Downgraded	Maintained/ Improved	Removed/ Downgraded	Maintained/ Improved
NWFP (FS,BLM,NPS)	211,669	561,036	275,958	97,136
Bureau of Indian Affairs / Tribes	114,099	28,372	2,398	0
Habitat Conservation Plans/Safe Harbor Agreements	339,692	14,539	N/A	N/A
Other Federal, State, County, Private Lands	68,813	28,447	2,392	0
Total Changes	**734,273**	**632,394**	**280,748**	**97,136**

Notes:

1. Nesting, roosting, foraging (NRF) habitat. In California, suitable habitat is divided into two components; nesting - roosting (NR) habitat, and foraging (F) habitat. The NR component most closely resembles NRF habitat in Oregon and Washington. Due to differences in reporting methods, effects to suitable habitat compiled in this, and all subsequent tables include effects for nesting, roosting, and foraging (NRF) for 1994-6/26/2001. After 6/26/2001 suitable habitat includes NRF for Washington and Oregon but only nesting/roosting (NR) for California.
2. Includes both effects reported in USFWS 2001 and subsequent effects reported in the Northern Spotted Owl Consultation Effects Tracking System (web application and database.)
3. Includes effects to suitable NRF habitat (as generally documented through technical assistance, etc.) resulting from wildfires (not from suppression efforts), insect and disease outbreaks, and other natural causes, private timber harvest, and land exchanges not associated with consultation.

Range-wide Consultation Effects: 2006/2007 to October 23, 2016

The Service updated the ECOS Database to reflect the 2006/2007 habitat baseline developed for the NWFP 15-year monitoring report (Davis *et al.* 2011, Appendix D, Table D). This mapping effort accounted for habitat loss due to wildfire, harvest, insects and disease, and indicates approximately 8.555 million acres of spotted owl nesting/roosting habitat existed on Federal lands in 2006/2007. Because the data developed for the NWFP monitoring program is only current through 2006/2007, the Service continues to rely on information compiled in the spotted owl consultation database to summarize current owl habitat trends at provincial and range-wide scales. Table 2 summarizes the habitat impacts on Federal lands that have occurred since 2006/2007.

Habitat loss from Federal lands since 2006/2007 due to land management activities and natural events has varied among the individual provinces with most of the impacts concentrated within the 'Non-Reserves' land-use allocations relative to the 'Reserve' land-use allocations (Table 2). When habitat loss is evaluated as a proportion of the affected acres range-wide, the most pronounced losses have occurred within Oregon (51.8 percent; especially within its Cascades West [23.9 percent] and Cascades East [17.9 percent] provinces; Table 2), followed by California (39.7 percent; with nearly all [37.7 percent] from the Klamath Province; Table 2). In contrast, much smaller habitat losses have occurred in Washington (8.53 percent; Table 2). When habitat loss is evaluated as a proportion of provincial baselines, the Oregon Cascades East (5.6

percent), and the California Klamath (3.81 percent) provinces have proportional losses greater than the loss of habitat across all provinces (1.67 percent; Table 2).

Of the total Federal acres consulted on for 'Habitat Removed/Downgraded' in Table 2, approximately 60,111 acres or 0.70 percent of 8.55 million acres of northern spotted owl habitat were removed/downgraded as a result of land management activities. Of these activities 53,848 acres were a result of timber harvest (Table 3). Table 2 also estimates northern spotted owl habitat lost due to 'Natural Events' (e.g., wildfires, wind throw, disease) at 82,687 acres range-wide, with the California Klamath province contributing the majority (52,394 acres or 63 percent) of habitat lost, followed by the Oregon Cascades East province (10,073 acres or 12 percent).

Other Habitat Trend Assessments

In 2005, the Washington Department of Wildlife released the report, "An Assessment of Spotted Owl Habitat on Non-Federal Lands in Washington between 1996 and 2004" (Pierce *et al.* 2005). This study estimates the amount of spotted owl habitat in 2004 on lands affected by state and private forest practices. The study area is a subset of the total Washington forest practice lands, and statistically-based estimates of existing habitat and habitat loss due to fire and timber harvest are provided. In the 3.2-million acre study area, Pierce *et al.* (2005) estimated there was 816,000 acres of suitable spotted owl habitat in 2004, or about 25 percent of their study area. Based on their results, Pierce *et al.* (2005) estimated there were less than 2.8 million acres of spotted owl habitat in Washington on all ownerships in 2004. Most of the suitable owl habitat in 2004 (56%) occurred on Federal lands, and lesser amounts were present on state-local lands (21%), private lands (22%) and tribal lands (1%). Most of the harvested spotted owl habitat was on private (77%) and state-local (15%) lands. A total of 172,000 acres of timber harvest occurred in the 3.2 million-acre study area, including harvest of 56,400 acres of suitable spotted owl habitat. This represented a loss of about 6 percent of the owl habitat in the study area distributed across all ownerships (Pierce *et al.* 2005). Approximately 77 percent of the harvested habitat occurred on private lands and about 15 percent occurred on State lands. Pierce and others (2005) also evaluated suitable habitat levels in 450 spotted owl management circles (based on the provincial annual median spotted owl home range). Across their study area, they found that owl circles averaged about 26 percent suitable habitat in the circle across all landscapes. Values in the study ranged from an average of 7 percent in southwest Washington to an average of 31 percent in the east Cascades, suggesting that many owl territories in Washington are significantly below the 40 percent suitable habitat threshold used by the State as a viability indicator for spotted owl territories (Pierce *et al.* 2005).

Moeur *et al.* 2005 estimated an increase of approximately 1.25 to 1.5 million acres of medium and large older forest (greater than 20 inches dbh, single and multi-storied canopies) on Federal lands in the NWFP area between 1994 and 2003. The increase occurred primarily in the lower end of the diameter range for older forest. In the greater than 30 inch dbh size class, the net area increased by only an estimated 102,000 to 127,000 acres (Moeur *et al.* 2005). The estimates were based on change-detection layers for losses due to harvest and fire and re-measured inventory plot data for increases due to ingrowth. Transition into and out of medium and large older forest

Table 2. Summary of northern spotted owl suitable habitat (NRF[1]) acres removed or downgraded as documented through Section 7 consultations on all Federal Lands within the Northwest Forest Plan area. Environmental baseline and summary of effects by State, Physiographic Province, and Land Use Function from 2006 to October 26, 2016.

State	Physiographic Province[2]	Evaluation Baseline (2006/2007)[3]			Habitat Removed/Downgraded[4]							% Provincial Baseline Affected	% Range-wide Effects
					Land Management Effects			Habitat Loss from Natural Events					
		Nesting/ Roosting Acres in Reserves	Nesting/ Roosting Acres in Non-Reserves	Total Nesting Roosting Acres	Reserves[5]	Non-Reserves	Total	Reserves	Non-Reserves	Total	Total NRF removed/ downgraded		
WA	Eastern Cascades	462,400	181,100	643,500	2,700	2,240	4,940	5,454	132	5,586	10,526	1.64	7.37
	Olympic Peninsula	729,000	33,400	762,400	6	0	6	0	1	1	7	0	0
	Western Cascades	1,031,600	246,600	1,278,200	779	877	1,656	3	0	3	1,659	0.13	1.16
	Western Lowlands	24,300	0	24,300	0	0	0	0	0	0	0	0	0
OR	Cascades East	248,500	128,400	376,900	2,994	7,865	10,859	7,639	2,434	10,073	20,932	5.55	14.66
	Cascades West	1,275,200	939,600	2,214,800	1,587	26,321	27,908	761	1,775	2,536	30,444	1.37	21.32
	Coast Range	494,400	113,400	607,800	750	1,891	2,641	0	0	0	2,641	0.46	1.85
	Klamath Mountains	549,400	334,900	884,300	2,999	7,368	10,367	5,736	3,840	9,576	19,943	2.26	13.97
	Willamette Valley	700	2,600	3,300	0	0	0	0	0	0	0	0	0
CA	Cascades	101,700	102,900	204,600	10	68	78	325	0	325	403	0.2	0.28
	Coast	132,900	10,100	143,000	274	1	275	0	2,193	2,193	2,468	1.73	1.73
	Klamath	910,900	501,200	1,412,100	317	1,064	1,381	24,301	27,974	52,394	53,775	3.81	37.66
Total		**5,961,000**	**2,594,200**	**8,555,200**	**12,416**	**47,695**	**60,111**	**44,338**	**38,349**	**82,687**	**142,798**	**1.67**	**100**

Notes:
[1]Nesting, roosting, foraging (NRF) habitat. In WA/OR, the values for Nesting/Roosting habitat generally represent the distribution of suitable owl habitat, including foraging habitat. In CA, foraging habitat occurs in a much broader range of forest types than what is represented by nesting/roosting habitat. Baseline information for foraging habitat as a separate category in CA is currently not available at a provincial scale in this database; however, California consultations use locally derived information to assess effects to foraging only.
[2]Defined in the Revised Recovery Plan for the Northern Spotted Owl (USFWS 2011) as Recovery Units as depicted on page A-3.
[3]Spotted owl nesting/roosting habitat on all Federal lands (includes USFS, BLM, NPS, DoD, USFWS, etc.) as reported by Davis *et al.* 2011 for the Northwest Forest Plan 15-Year Monitoring Report (PNW-GTR-80, Appendix D). NR habitat acres are approximate values based on 2006 (OR/WA) and 2007 (CA) satellite imagery.
[4]Estimated NRF habitat removed or downgraded from land management (timber sales) or natural events (wildfires) as documented through section 7 consultations or technical assistance. Effects reported here include all acres removed or downgraded from 2006 to present. Effects in California reported here only include effects to Nesting/Roosting habitat. Foraging habitat that is independent of Nesting/Roosting habitat but is removed or downgraded in California is not summarized in this table.
[5]Reserve land use allocations under the NWFP intended to provide demographic support for spotted owls include LSR, MLSA, and CRA. Non-reserve allocations under the NWFP intended to provide dispersal connectivity between reserves include AWA, AMA, and MX.

Table 3: Summary of northern spotted owl suitable habitat (NRF)[1] acres removed or downgraded on Federal lands within the Northwest Forest Plan area through timber harvest, natural disturbance, or other management actions as documented through section 7 consultation and technical assistance. Range-wide changes by land-use function from 2006 to October 26, 2016.

Suitable Habitat (NRF) Effects	Reserves (LSR, MLSA, CRA)[3]	Non-reserves (AWA, AMA, Matrix)[3]	Totals
Evaluation Baseline (2006/2007)[2]	5,961,000	2,594,200	8,555,200
Removed/Downgraded (timber harvest only)[4]	8,756	45,092	53,848
Removed/Downgraded (other management activities)[5]	3,660	2,603	6,263
Subtotal	12,416	47,695	60,111
Removed/Downgraded (natural disturbance)[6]	44,338	38,349	82,687
Total Net Change	56,754	86,044	142,798
Baseline Balance	**5,904,246**	**2,508,156**	**8,412,402**
Habitat Maintained[7]	54,101	144,774	198,875

Notes: [1]Nesting, roosting, foraging (NRF) habitat. In WA/OR, the values for Nesting/Roosting habitat generally represent the distribution of suitable owl habitat, including foraging habitat. In CA, foraging habitat occurs in a much broader range of forest types than what is represented by nesting/roosting habitat. Baseline information for foraging habitat as a separate category in CA is currently not available at a provincial scale. Effects to spotted owl habitat in California reported here include effects to Nesting/Roosting habitat only. Foraging habitat removed or downgraded in California is not summarized in this table; California consultations use locally derived information to assess effects to foraging only.

[2]Spotted owl nesting/roosting habitat on all Federal lands (includes USFS, BLM, NPS, DoD, USFWS, etc.) as reported by Davis *et al.* 2011 for the Northwest Forest Plan 15-Year Monitoring Report (PNW-GTR-80, Appendix D). NR habitat acres are approximate values based on 2006 (OR/WA) and 2007 (CA) imagery.
[3]Reserve land use allocations under the NWFP intended to provide demographic support for spotted owls include LSR, MLSA, and CRA. Non-reserve allocations under the NWFP intended to provide dispersal connectivity between reserves include AWA, AMA, and MX.
[4]NRF habitat removed or downgraded from timber harvest on Federal lands.
[5]NRF habitat removed or downgraded from recreation, roads, minerals, or other non-timber programs.
[6]NRF habitat losses resulting from wildfires, insect and disease, windthrow or other natural causes.
[7]Habitat maintained means that stands have been modified by management, but the habitat function remains the same.

over the 10-year period was extrapolated from inventory plot data on a subpopulation of Forest Service land types and applied to all Federal lands. Because size class and general canopy layer descriptions do not necessarily account for the complex forest structure often associated with northern spotted owl habitat, the significance of these acres to northern spotted owl conservation remains unknown.

In 2011, Davis *et al.* produced the second in a series of monitoring reports on northern spotted owl population and habitat trends on Northwest Forest Plan administered lands. They summarized demographic analyses from Forsman *et al.* (2011) discussed below under trends in numbers, distribution and reproduction, and reported on a new effort using remotely sensed data from 1994 to 2007 to develop "habitat suitability" models, and ultimately suitable habitat maps for the entire range of the northern spotted owl for each of these time periods. They also created change-detection maps and reported on the cause of habitat change during this time period. The authors suggest that because of improvements in remotely sensed vegetation, and change-detection mapping, their habitat maps represent the best available information and should replace the baseline versions used for the first monitoring report. Davis *et al.* (2011) estimated 8.9 million acres of suitable habitat for the 1994 baseline map, as compared to 7.4 million acres estimated by FEMAT in 1994, and 10.3 million acres estimated by Davis and Lint (2005) for the 10-year report.

Davis *et al.* (2011) were not able to report on gains in nesting/roosting habitat suitability due to issues with current technology, and the need for additional time to capture the slow process of forest succession. However, they were able to report on gains in recruitment of younger forests or dispersal habitat. They estimated a gain of about 1.26 million ac of dispersal habitat, with the greatest increases in nonreserves than reserves. The largest increase in dispersal habitat was in the Oregon Coast Range province.

Davis *et al.* (2011) estimated that nesting/roosting habitat declined by 3.4 percent (298,600 ac) rangewide on Federal lands since 1994, which is less than the anticipated rate of habitat loss under the NWFP of 5 percent per decade. Most of the loss (79 percent) occurred within reserves and was the result of wildfires. Wildfires also were responsible for about half of the loss in nonreserves. Timber harvest accounted for about 45 percent (37,400 ac) in nonreserves, and 7 percent (16,000 ac) in reserves. The Oregon Klamath province lost the most nesting/roosting habitat (93,730 ac) due to the Biscuit Fire in 2002. They estimated a rangewide loss of about 417,000 ac of dispersal habitat, but like nesting/roosting habitat, most of the loss of dispersal habitat was due to wildfire.

Davis *et al.* (2011) created a wildfire suitability (likelihood) map for large fires throughout the range of the northern spotted owl. Their goal was to identify landscape-scale areas where large wildfires are more probable. They report that the California Klamath province has the most owl habitat in fire-prone landscapes, followed by the Oregon Western Cascades and Oregon Klamath provinces.

Spotted Owl Population Trends and Distribution

There are no estimates of the historical population size and distribution of spotted owls, although they are believed to have inhabited most old-growth forests throughout the Pacific Northwest prior to modern settlement (mid-1800s), including northwestern California (USFWS 1989, pp. 2-17).

The current range of the spotted owl extends from southwest British Columbia through the Cascade Mountains, coastal ranges, and intervening forested lands in Washington, Oregon, and California, as far south as Marin County (Service 1990a, p. 26114). The range of the spotted owl is partitioned into 12 physiographic provinces (Fig. 1) based on recognized landscape subdivisions exhibiting different physical and environmental features (USFWS 1992a, p. 31). The spotted owl has become rare in certain areas, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon.

As of July 1, 1994, there were 5,431 known site-centers of spotted owl pairs or resident singles: 851 sites (16 percent) in Washington, 2,893 sites (53 percent) in Oregon, and 1,687 sites (31 percent) in California (Service 1995, p. 9495). The actual number of currently occupied spotted owl locations across the range is unknown because many areas remain unsurveyed (USFWS 2011b, p. A-2). In addition, many historical sites are no longer occupied because spotted owls have been displaced by barred owls, timber harvest, or severe fires, and it is possible that some new sites have been established due to reduced timber harvest on Federal lands since 1994. The totals above represent the cumulative number of locations recorded in the three states, not population estimates.

Because the existing survey coverage and effort are insufficient to produce reliable range-wide estimates of population size, demographic data are used to evaluate trends in spotted owl populations. Analysis of demographic data can provide an estimate of the finite rate of population change (λ), which provides information on the direction and magnitude of population change. A λ of 1.0 indicates a stationary population, meaning the population is neither increasing nor decreasing. A λ of less than 1.0 indicates a decreasing population, and a λ of greater than 1.0 indicates a growing population. Demographic data, derived from studies initiated as early as 1985, have been analyzed periodically to estimate trends in the populations of the spotted owl (Anderson and Burnham 1992, Anthony *et al.* 2006, Burnham *et al.* 1994, Forsman *et al.* 1996, Forsman *et al.* 2011, Dugger *et al.* 2016).

As described above, after the implementation of the NWFP, populations were expected to decline in the short term, and then stabilize or increase after 50–100 years (Thomas *et al.* 1990, Lint *et al.* 1999). Previous demographic analyses suggested that populations confirmed this projection, but the rates of decline began to taper through 2009 (Dugger *et al.* 2016, Table 26,

p.97); however, these rates have varied among study areas (Franklin *et al.* 1999, Anthony *et al.* 2006, Forsman *et al.* 2011).

The most recent meta-analysis results, which included data from 1985-2013, suggest that the rates of decline have now increased range-wide (Dugger *et al.* 2016, entire), as summarized in Table 4. Estimated declines in annual rates of population change and occupancy were found to continue from past reports in all parts of their range. That rate of decline was increasing in many areas, including southern Oregon and Northern California (Dugger *et al.* 2016, p. 91).

Table 4. Summary of spotted owl population trends in demographic study areas (Dugger *et al.* 2016, Table 25, p.97).

Study Area	Fecundity	Apparent Survival	Occupancy Rates	Mean λ / λ	% population change[1]
Cle Elum	Declining	Declining	Declining	0.916/No trend	-77%
Rainier	No trend	Declining	Declining	0.953/No trend	-61%
Olympic	No trend	No trend	Declining	0.961/No trend	-59%
Coast Ranges	Declining	No trend	Declining	0.949/Declining	-64%
HJ Andrews	Declining	Declining	Declining	0.965/Declining	-47%
Tyee	Declining	Declining	Declining	0.976/Declining	-31%
Klamath	Declining	No trend	Declining	0.972/Declining	-34%
Southern Cascades	No trend	Declining	Declining	0.963/No trend	-44%
NW California	Declining	Declining	Declining	0.970/Declining	-55%
Hoopa	Declining	Declining	Declining	0.977/Declining	-32%
Green Diam. – CB[2]	Declining	Declining	Declining	0.988/Declining	-31%
Green Diam. – TB[3]	Declining	Declining	Declining	0.961/Declining	-26%
Green Diam. – CA[4]	**	**	Declining	0.878/**	-41%
Green Diam. – TA[5]	**	**	N/A[6]	1.030/**	-9%-

[1]With the exception of the Green Diamond study area, percent population change was based on estimates of *realized population change* in 2011, the last year for which an estimate of population change could be generated.
[2]CB = control before barred owl removal
[3]TB = treatment before removal
[4]CA = control after removal
[5]TA = treatment after removal
[6]Data used for occupancy modeling in the GDR study area excluded treatment areas after experimental Barred Owl removals began in 2009.
**Too few years since experimental Barred Owl removal to evaluate a trend.

Individual study area *annual rates of population change* (λ) were based on capture histories for 5,992 territorial owls from all age classes. Almost all study areas showed declining population trends, with strong evidence of declines in all of Washington study areas, the coastal and HJ Andrews study areas in Oregon, and three California study areas. Less of a decline was found in Tyee, Klamath, and Cascades study areas of Oregon. The only study area indicating an increasing population was in Green Diamond treatment areas after experimental barred owl removals began in 2009 (GDR-TA). The rates of decline were variable across the range; the highest were in Green Diamond control areas (GDR-CA) after 2009 (12.0 percent annual decline) and the Washington Cle Elum study area (8.4 percent); the lowest was in Green

Diamond control areas before experimental barred owl removal began 2009 (1.2 percent annual decline). The weighted mean population change for all study areas (excluding GDR-TB) was an estimated decline of 3.8 percent per year from 1985-2013 (Dugger *et al.* 2016, p.70-71). This is an increased decline from 2.8 percent reported by Forsman *et al.* (2011).

Recent estimates of *realized population change* (change in populations since studies were initiated) showed sharper declines in the northern portion of the range (Dugger *et al.* 2016, pp. 71-72). Populations in Washington declined by 55–77 percent; sites in Oregon ranged from 31 percent in TYE to 68 percent in COA. Two cases in Oregon were more uncertain (KLA and TYE): the 95% confidence intervals widely overlapped 1.0 for most or all of the last several years, indicating uncertainty about annual rates of population change. Declines in California ranged from 32-55 percent, with exceptions in HUP and treatment areas of GDR (GDR-T), where confidence limits overlapped 1.0 in many years, indicating uncertainty about annual rates of population change in these areas.

Decreases in adult apparent survival rates were an important factor contributing to decreasing population trends. Dugger *et al.* (2016, p.58) found strong evidence that barred owls negatively affected spotted owl populations, largely from increasing local territory extinction rates and decreasing apparent survival. The amount of suitable habitat, local weather, and regional climatic patterns also were related to survival, occupancy (via colonization rate), and recruitment. Associated effects to fecundity were weaker. Five of the 11 study areas included either a negative linear or log-linear time trend on survival.

There are few spotted owls remaining in British Columbia. Chutter *et al.* (2004, p. v) suggested immediate action was required to improve the likelihood of recovering the spotted owl population in British Columbia. In 2007, personnel in British Columbia captured and brought into captivity the remaining 16 known wild spotted owls (USFWS 2011b, p. A-6). Prior to initiating the captive-breeding program, the population of spotted owls in Canada was declining by as much as 10.4 percent per year (Chutter *et al.* 2004, p. v). The amount of previous interaction between spotted owls in Canada and the United States is unknown.

Spotted Owl Recovery Units

The 2011 Final Revised Recovery Plan for the Northern Spotted Owl determined that the 12 existing physiographic provinces meet the criteria for use as recovery units (Service 2011b, p. III 1-2). Recovery criteria, as described in the 2011 Final Revised Recovery Plan (p. 11-3), are measurable and achievable goals that are believed to result through implementation of the recovery actions described in the recovery plan. Achievement of the recovery criteria will take time and are intended to be measured over the life of the plan, not on a short-term basis. The criteria are the same for all 12 identified recovery units. The four recovery criterion are: 1) stable population trend, 2) adequate population distribution, 3) continued maintenance and recruitment of northern spotted owl habitat, and 4) post-delisting monitoring (Service 2011b, p III-3).

The California Klamath physiographic province and recovery unit covers approximately six million acres and extends from the Oregon-California border south to the Clear Lake Basin within the Northern California Coast Ranges. Since 2006/2007, there has been a 46,725-acre (2.85 percent) reduction in the amount of habitat within the California Klamath physiographic

province and recovery unit (Table 2). Of the 46,725-acre reduction in habitat, 46,001 acres were associated with natural events and 724 acres were associated with actions on NWFP lands.

Demographic data are used to evaluate trends in northern spotted owl populations. Annual reports from two of these study areas represent the best source of information on population trends that may be occurring in the recovery unit and action area. The Southern Oregon Cascades Demographic Study Area (DSA) includes portions of the Rogue River-Siskiyou, Fremont-Winema, and Umpqua National Forests. The Willow Creek and Regional Study Areas partially overlap portions of the SRNF, Klamath, and Shasta-Trinity National Forests, and lands managed by the Bureau of Land Management.

Southern Oregon Cascades Demographic Study Area

The fiscal year 2014 report from the Southern Oregon Cascades DSA was completed in February of 2015 (Dugger *et al.* 2015). In 2014, 31 percent of the 170 territories monitored were occupied, which is a 4 percent decrease from 2013; the number of pairs detected was 36 (Dugger *et al.* 2015, p. 4). Of the 36 owl pairs detected, 28 pairs nested and produced an average of 1.68 young per successful pair, which is similar to the average for all years (1.60) of the study (Dugger *et al.* 2015, p. 6). In 2014, the average number of young fledged per pair (1.34) was greater than the average for all years of the study (0.69; Dugger *et al.* 2015, p. 6).

Willow Creek and Regional Study Areas

The calendar year 2014 report from the Willow Creek and Regional Study Areas was completed in March of 2015 (Franklin *et al.* 2015). In 2014, 31.9 percent of the 94 territories monitored were occupied, which is a 3.2 percent decrease from 2013; the number of pairs detected remained steady at 26, the same number detected in 2013 (Franklin *et al*, 2014, pp. 5, 11; Franklin *et al.* 2015, pp. 6, 16). Of the 26 owl pairs detected in 2014, 21 pairs nested and 12 of those pairs were monitored for reproductive success with an average of 1.9 young produced, which is above the average for all years (1.59) of the study (Franklin *et al.* 2015, pp. 19-21). In 2014, the average number of young fledged per pair (0.96) was greater than the average for all years of the study (0.58; Franklin *et al.* 2015, pp. 20-21).

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