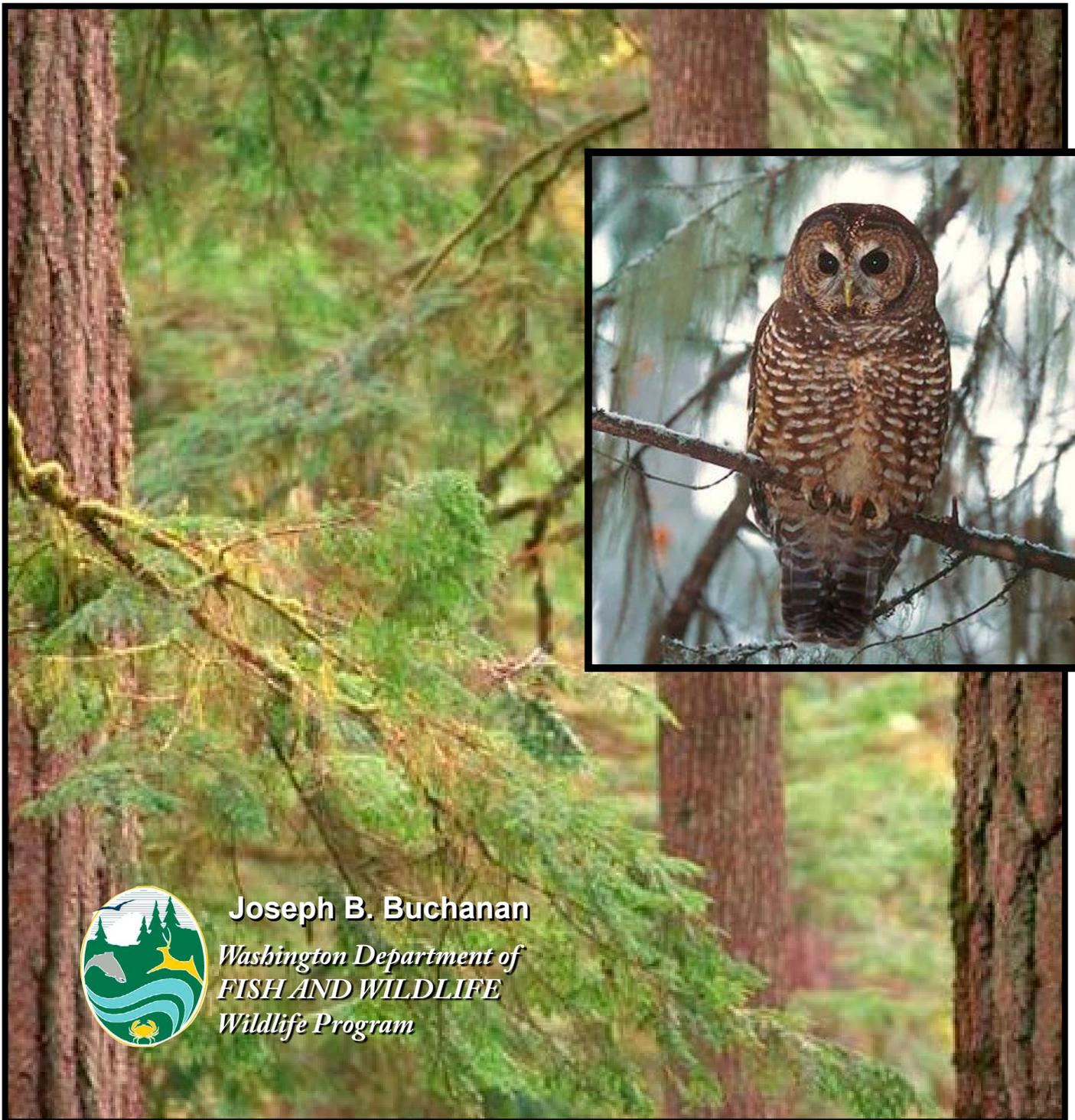


Periodic Status Review for the Northern Spotted Owl



Joseph B. Buchanan

*Washington Department of
FISH AND WILDLIFE
Wildlife Program*

The Washington Department of Fish and Wildlife maintains a list of endangered, threatened, and sensitive species (Washington Administrative Codes 232-12-014 and 232-12-011). In 1990, the Washington Wildlife Commission adopted listing procedures developed by a group of citizens, interest groups, and state and federal agencies (Washington Administrative Code 232-12-297). The procedures include how species listings will be initiated, criteria for listing and delisting, a requirement for public review, the development of recovery or management plans, and the periodic review of listed species.

The Washington Department of Fish and Wildlife is directed to conduct reviews of each endangered, threatened, or sensitive wildlife species at least every five years after the date of its listing by the Washington Fish and Wildlife Commission. The periodic status reviews are designed to include an update of the species status report to determine whether the status of the species warrants its current listing status or deserves reclassification. The agency notifies the general public and specific parties who have expressed their interest to the Department of the periodic status review at least one year prior to the five-year period so that they may submit new scientific data to be included in the review. The agency notifies the public of its recommendation at least 30 days prior to presenting the findings to the Fish and Wildlife Commission. In addition, if the agency determines that new information suggests that the classification of a species should be changed from its present state, the agency prepares documents to determine the environmental consequences of adopting the recommendations pursuant to requirements of the State Environmental Policy Act.

This document is the final Periodic Status Review for the Northern Spotted Owl. It contains a review of information pertaining to the status of the Spotted Owl in Washington. It was reviewed by species experts and was available for a 90-day public comment period. All comments received were considered during the preparation of the final periodic status review. The Department presented the results of this periodic status review to the Fish and Wildlife Commission at the 22-23 January 2016 meeting in Vancouver. The recommendation to keep the Northern Spotted Owl listed as endangered was affirmed by the Commission at their 26 February meeting in Olympia.

This report should be cited as:

Buchanan, J. B. 2016. Periodic status review for the Northern Spotted Owl in Washington. Washington Department of Fish and Wildlife, Olympia, Washington. 22 + iv pp.

On the cover: photos of Northern Spotted Owl and habitat by Jared Hobbes



This work was supported in part by personalized and endangered species license plates



Periodic Status Review for the Northern Spotted Owl in Washington

Prepared by
Joseph B. Buchanan

Washington Department of Fish and Wildlife
Wildlife Program
600 Capitol Way North
Olympia, WA 98501-1091

January 2016

TABLE OF CONTENTS

ACKNOWLEDGMENTS	ii
EXECUTIVE SUMMARY	iii
INTRODUCTION	1
DISTRIBUTION.....	1
NATURAL HISTORY	2
POPULATION AND HABITAT STATUS	4
FACTORS AFFECTING CONTINUED EXISTENCE	7
MANAGEMENT ACTIVITIES.....	9
CONCLUSION AND RECOMMENDATION.....	11
REFERENCES CITED.....	12
Appendix A. WDFW responses to public comments	19

LIST OF TABLES

Table 1. Summary of estimated changes in habitat on all lands between 1993 and 2012.....	5
Table 2. Summary of demographic values from three study areas in Washington	6

LIST OF FIGURES

Figure 1. Spotted Owl	1
Figure 2. Potential range of the Spotted Owl in Washington	2
Figure 3. Representation of 20-year population declines at study areas in Washington	6

ACKNOWLEDGMENTS

This document was improved by reviews and constructive comments provided by Gary Bell, Steve Desimone, Karl Halupka, Kevin Kalasz, and Peter Singleton.

EXECUTIVE SUMMARY

The Northern Spotted Owl (*Strix occidentalis caurina*; hereafter, Spotted Owl) was listed as an Endangered Species in Washington State by the Washington Fish and Wildlife Commission in 1988, and was listed as a Threatened Species under the Endangered Species Act in 1990. This is one of three Spotted Owl subspecies and the only one to occur in the Pacific Northwest. Its distribution is from extreme southwestern British Columbia south through the Cascade Range and coastal mountains to northwestern California. Spotted Owls have very large home ranges (thousands of acres) and use mature and old coniferous forest habitat for nesting, roosting and foraging; loss of this habitat due to timber harvest was the primary reason for its listing. Protections on federal (Northwest Forest Plan) and nonfederal lands (Forest Practices Rules) have reduced the amount of habitat loss, although authorized habitat loss continues under these and other initiatives such as federal habitat conservation plans. Population monitoring at three demography study areas in Washington indicate annual rates of change between -3.9 and -8.4%. The closely related Barred Owl expanded its range across North America and arrived in the Pacific Northwest about 45 years ago. The range of the Barred Owl has continued to expand, and it now is found throughout the range of the Spotted Owl. The Barred Owl has life history traits that enable it to be a more effective competitor of resources than the Spotted Owl, and this competitive advantage has contributed substantially to the continuing population decline of the Spotted Owl in Washington. A variety of management actions are underway to enhance Spotted Owl conservation in Washington and elsewhere within its range. In particular, a landscape-scale experiment to remove Barred Owls from Spotted Owl territories at four study areas was implemented in autumn of 2015; one of the study areas is in the eastern Cascade Range in Washington. The decline of Spotted Owls has not subsided in Washington and the population is becoming critically imperiled. The U.S. Fish and Wildlife Service currently is evaluating whether to change the species' status to Endangered under the Endangered Species Act. We recommend that the status remain as Endangered in Washington State.

INTRODUCTION

Fourteen species of owls are known to occur in Washington, all except one of which breed or are thought to breed in this state. Of these species, 10 are associated with forests in at least part of their Washington range, and seven species, including the Spotted Owl, are largely or exclusively associated with forests.

The Northern Spotted Owl (*Strix occidentalis caurina*; hereafter, Spotted Owl; Fig. 1) is one of three recognized Spotted Owl subspecies (Funk et al. 2008) and is the only one that is found in the Pacific Northwest, ranging from extreme southwestern British Columbia to northern California (Gutiérrez et al. 1995). The Spotted Owl was listed as endangered by the State of Washington in 1988, and as federally threatened by the U.S. Fish and Wildlife Service in 1990 (U.S. Fish and Wildlife Service 1990).

In this periodic status review we briefly summarize the natural history, population status, threats, and recent conservation and management activities involving Spotted Owls in Washington. In addition, we assess whether the species should retain its current status or if it deserves reclassification under state law, and provide a recommendation for the Washington Fish and Wildlife Commission to consider.

DISTRIBUTION

The range of the Spotted Owl includes conifer forests of western Washington and the eastern slope of the Cascade Range (Buchanan 2005). Nearly all Spotted Owls are currently found in the Cascade Range and on the Olympic Peninsula (Fig. 2). It no longer occurs in the Puget Lowlands and only 14 Spotted Owl locations have ever been documented in southwestern Washington (Wildlife and Surveys Data Management, Washington Department of Fish and Wildlife). Spotted Owls have been documented from coastal areas near sea level to their upper elevation range which varies from about 3000 feet in the Olympic Mountains to about 5000 feet in parts of the Cascade Range (Buchanan 2005). Within the Cascades, the density of Spotted Owls is generally higher in the south and becomes sparse north of Lake Chelan and the Skagit River. The Spotted Owl is not known to commonly cross large water bodies and for this reason may not have occurred in the San Juan Islands, where there are no known records.



Figure 1. Spotted Owl (photo by Jared Hobbs).

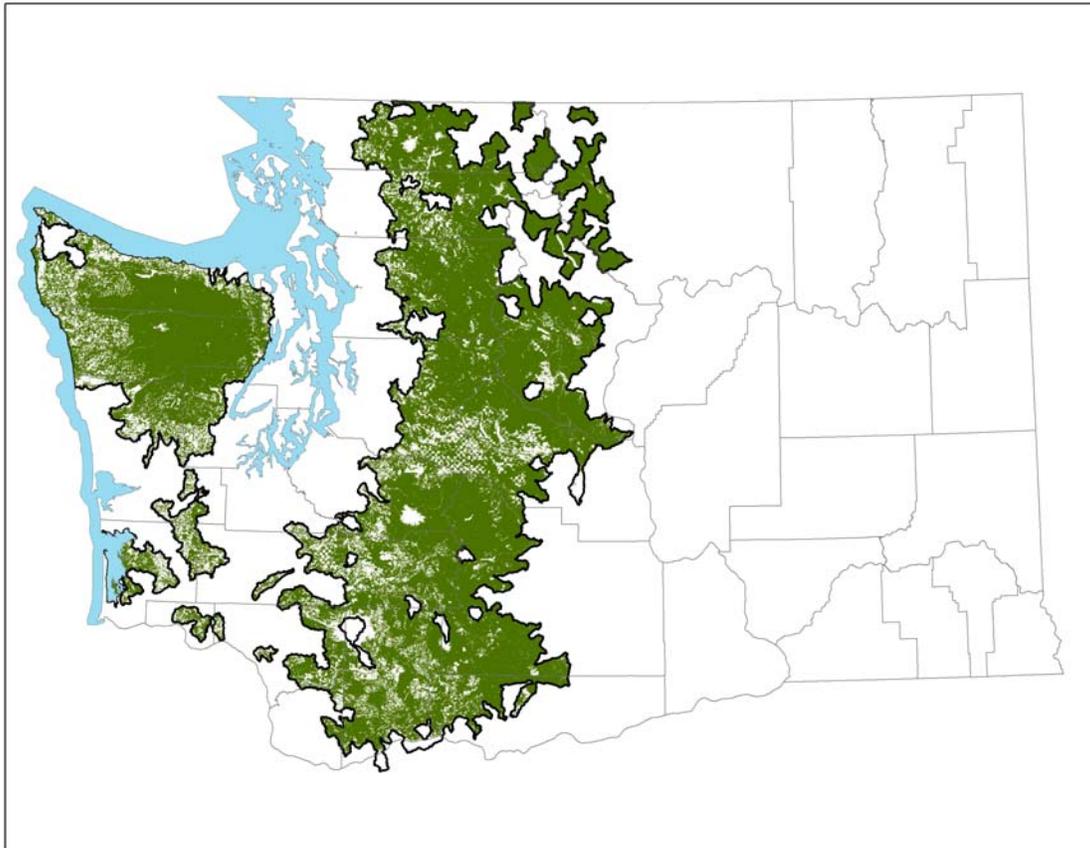


Figure 2. Potential range of the Spotted Owl in Washington, as depicted by the spatial extent of multiple ecological systems (in green; boundaries of specific ecological systems not shown) in HUC-12 watersheds (black outline) that have supported territorial owls at any point in time since the 1970s. Site location data used to create this map are from the Wildlife and Surveys Data Management database, Washington Department of Fish and Wildlife. For more details about ecological systems and methods used to create species maps, see WDFW (in review).

NATURAL HISTORY

Habitat requirements. Spotted Owls are birds of the forest. In western Washington, these owls use mature and old-growth forests that contain large-diameter trees, snags, and downed wood. Other habitat features include high canopy cover and multiple size-classes of trees (largely expressed in terms of height) which results in a complex of canopy layers. In eastern Washington, Spotted Owls use old-growth forests, particularly near the crest of the Cascade Range, but much of the habitat in that region is best characterized as forests that are either comparatively young or mature. Snags and downed wood are less consistently present in the drier east-side forests which also contain dwarf mistletoe, usually the variety associated with Douglas-fir, which creates a dense branching pattern often used as a nest platform by Spotted

Owls. Spotted Owls use forests dominated by Douglas-fir, grand fir, western hemlock, and several other coniferous species; western larch, lodgepole pine, ponderosa pine, and hardwoods are typically a minor component of Spotted Owl habitat in Washington (Hanson et al. 1993). Habitat conditions used by roosting Spotted Owls during dispersal in the eastern Cascade Range are described by Sovern et al. (2015).

Diet and foraging. Spotted Owls prey on a variety of species that they capture within the forest environment. Studies of Spotted Owl food habits in Washington indicate that many species are taken, including a variety of small mammals, and less frequently small birds and invertebrates, and that certain species are more important in terms of the number or biomass of items consumed. The most important prey of the Spotted Owl in Washington is the northern flying squirrel; other species commonly taken include bushy-tailed woodrat and snowshoe hare (Forsman et al. 2001).

Home range and movements. Spotted Owls in Washington have home ranges that exceed the size of those from other parts of the subspecies' distribution (see summary in Hamer et al. 2007). Home range estimates for Spotted Owls in Washington were initially reported by Hanson et al. (1993) in a report written for the Forest Practices Board to facilitate development of forest practices rules. Those data were subsequently analyzed more comprehensively by the principal investigators and are summarized here. Estimates of home range sizes (100% minimum convex polygon) have been documented from the Olympic Peninsula: mean = 8,916 acres (Forsman et al. 2005) and the eastern Cascade Range: mean = 7,124 acres (Forsman et al. 2015). A 95% adaptive kernel estimated mean for the northwestern Cascade Range was 6,571 acres (Hamer et al. 2007). Home range shape (i.e., as defined by the actual area used) varies from one year to the next, likely as a consequence of changing prey distributions across the landscape (Carey and Peeler 1995), and this influences the size of two-year home ranges used by pairs of Spotted Owls which are larger than annual home ranges for individual owls or pairs (Forsman et al. 2005). Spotted Owl home ranges include areas used during winter that are never or less frequently used during the breeding season; these include locations adjacent to the breeding-season area ("winter expansion") and seasonal movements to areas at some distance (e.g. up to 6 miles in the northwestern Cascades) from the breeding location ("winter migration") after which they return to the breeding area the following spring (Hamer et al. 2007).

In comparison to annual movements associated with territories, dispersal movements by Spotted Owls are more extensive. Two types of dispersal have been documented: dispersal of juveniles from the natal site, which is referred to as natal dispersal and, much less frequently, dispersal from a breeding area by adults which is referred to as breeding dispersal. Natal dispersal typically begins between 25 September and 4 October (95% confidence interval) and the mean distance of dispersing juveniles in Oregon and Washington was 8.4 – 9.1 miles for males and 14.2 – 15.2 miles for females; within-sex differences were related to whether owls were banded only or also equipped with transmitters. Mean breeding dispersal distances were 3.8 miles (Forsman et al. 2002).

Reproduction and survival. Ongoing investigations of Spotted Owl demography are summarized and reported in comprehensive updates that are published approximately every 4-5

years. This review includes information through 2013 that was presented by Dugger et al. (2016) on the three demography study area landscapes in Washington: Cle Elum (primarily U.S. Forest Service land in the central-eastern Cascade Range), Olympic (Olympic National Park and vicinity), and Rainier (central-western Cascade Range, including areas outside the national park). Key findings were that rates of apparent survival had continued to decline and that fecundity (mean number of female fledglings per female adult per year) had declined at Cle Elum. There is little evidence that habitat conditions or the presence of Barred Owls, a species which competitively interacts with Spotted Owls (see below), influenced observed fecundity at any study areas in Washington. On the other hand, the presence of Barred Owls is associated with a negative trend in apparent survival at two Washington study areas and at up to 7 of 10 study areas range-wide. The annual rate of population change indicates a negative trend at all three demography study areas in Washington (see Population and Habitat Status). Through the 1990s, Spotted Owls exhibited a pattern of alternating years of high and low levels of reproduction at many demography study areas; this pattern has persisted at Olympic and Rainier study areas through 2013, but not at the Cle Elum study area (Dugger et al. 2016). Several raptors may prey on Spotted Owls (e.g. Northern Goshawk, Red-tailed Hawk, Barred Owl, Great Horned Owl), although supporting evidence is virtually absent or circumstantial (Gutiérrez et al. 1995). Additional information on breeding behavior and other components of demography is available (Forsman et al. 1984, Gutiérrez et al. 1995, Gutiérrez et al. 1996, Anthony et al. 2006, Glenn et al. 2011).

POPULATION AND HABITAT STATUS

Global. The Spotted Owl is found in some of the most productive forests in the world. Its range includes an estimated 48.2 million acres of coniferous forest lands in British Columbia, Washington, Oregon and northern California (Chutter et al. 2004, Davis et al. in press). As of 2004 (British Columbia) and 2006/2007 (United States), about 30% (14.6 million acres) of this forest was Spotted Owl habitat (Chutter et al. 2004, Davis et al. in press). In the United States, trends of habitat on all land ownerships in Washington, Oregon and California indicate a net loss of -12.9%, or 1.6 million acres between 1993 and 2012 (Davis et al. in press). The estimated amount of Spotted Owl habitat (e.g., 30% of habitat in the species' range) is at the approximate low end of the historical range of variability based on landscape assessments conducted in western Oregon that suggest a substantial area (e.g., between 25-75% of a landscape) of old forest was present prior to European settlement (Wallin et al. 1996, Wimberly et al. 2000, Wimberly 2002).

The Spotted Owl is experiencing a population decline over much of its range. In British Columbia, the population is thought to have declined by 67% between 1992 and 2002 (10.4% per year), and may have declined by over 90% since European settlement (Chutter et al. 2004). Estimates of population change at demography study areas in the United States indicate declines at all 3 study areas in Washington, at 2 of 5 study areas in Oregon, and at all 3 study areas in California (Dugger et al. 2016).

Washington. Current information on habitat in Washington is derived from the most recent publication in a series of monitoring reports on implementation of the Northwest Forest Plan.

The Northwest Forest Plan was developed to meet the dual needs of protecting forest habitat for the Spotted Owl (and other species) and a sustainable level of timber harvest from federal lands. Improvements in methodology were made between the assessment reported in 2011 (Davis et al. 2011) and the most current assessment (Davis et al. in press), and this influenced estimates of habitat. For example, the 2011 estimate of habitat on non-federal lands in 1994/1996 was 1.26 million acres (Davis et al. 2011), whereas the most recent estimate for 1993 was 924,500 acres (Davis et al. in press). Estimated changes in habitat were reported in all parts of the state and the primary losses of habitat were related to timber harvest, wildfire, and insect outbreaks, with timber harvest on non-federal lands comprising the greatest loss of habitat (Table 1). Changes in Spotted Owl habitat under the Washington State Forest Practices Rules (which directs forest practices on nonfederal lands) between 1996 and 2004 were reported by Pierce et al. (2005).

Following European settlement of western Washington, many low elevation forests had already been harvested multiple times when the Spotted Owl was classified as Endangered by the Fish and Wildlife Commission in 1988. The majority of known sites are in the Cascades and the Olympic Peninsula (Wildlife and Surveys Data Management, Washington Department of Fish and Wildlife). Most of the Spotted Owl sites in Washington are classified as territorial (i.e., site status 1, 2 and 3). As of July 2015, 939 of 1268 known Spotted Owl sites were classified as Status 1 (pair or reproductive), 21 were Status 2 (two birds, pair status unknown), 112 were Status 3 (territorial single), 165 were Status 4 (single, territorial status unknown), and 31 were Status 5 (historical). The latter two categories of sites are not protected under Washington’s Forest Practices Rules (WAC 222-16-010). These sites, in total, represent all known sites

Table 1. Summary of estimated changes in habitat (in acres) on all lands between 1993 and 2012 (data from Davis et al. in press).

Province	1993 habitat estimate	Harvest	Wild-fire	Insect	Other	Total explained loss	Percentage loss from 1993
Federal lands							
Olympic Peninsula	765,800	1,700	1,000	800	2,200	5,770	-0.7
Western Lowlands	12,900	0	0	0	600	600	-4.7
Western Cascades	1,157,700	6,900	2,600	900	3,500	13,900	-1.2
Eastern Cascades	832,700	24,400	52,100	34,000	3,100	113,600	-13.6
Non-federal lands							
Olympic Peninsula	170,400	39,700	0	1,700	0	41,330	-24.3
Western Lowlands	171,600	81,200	0	1,400	0	82,600	-48.1
Western Cascades	234,000	64,500	300	1,100	0	65,900	-28.2
Eastern Cascades	348,500	85,700	6,500	6,500	0	98,700	-28.3
Totals							
Federal lands	2,769,100	33,000	55,700	35,700	9,400	133,800	-4.8
Non-federal lands	924,500	271,100	6,800	10,700	0	288,600	-31.2
All forest areas	3,693,600	304,100	62,500	46,400	9,400	422,400	-11.4

Table 2. Summary of selected demographic values from three study areas in Washington (from Dugger et al. 2016). These values represent cumulative rates across the study period for each study area.

Demography Study Areas	Probability of occupancy (in 1995 and 2013)	Mean fecundity of adult females	Apparent survival of adult females	Lambda value	Annual rate of population change
Cle Elum	0.555; 0.113	0.570	0.836	0.916	-8.4%
Olympic	0.811; 0.209	0.294	0.852	0.961	-3.9%
Rainier	1.000; 0.256	0.264	0.835	0.953	-4.7%

documented since the 1970’s. Monitoring data and demography analyses (see below) indicate that many of these sites are not currently occupied by Spotted Owls.

The annual rate of population change continues to decline significantly at all three demography study areas in Washington (Table 2), where monitoring has been ongoing for over 20 years. The rate of decline (i.e., the values in the right-hand column in Table 2) is depicted for all three study areas, on a cumulative basis over a 20-year period, in Figure 3. It should be noted that these values are specific to the particular study areas.

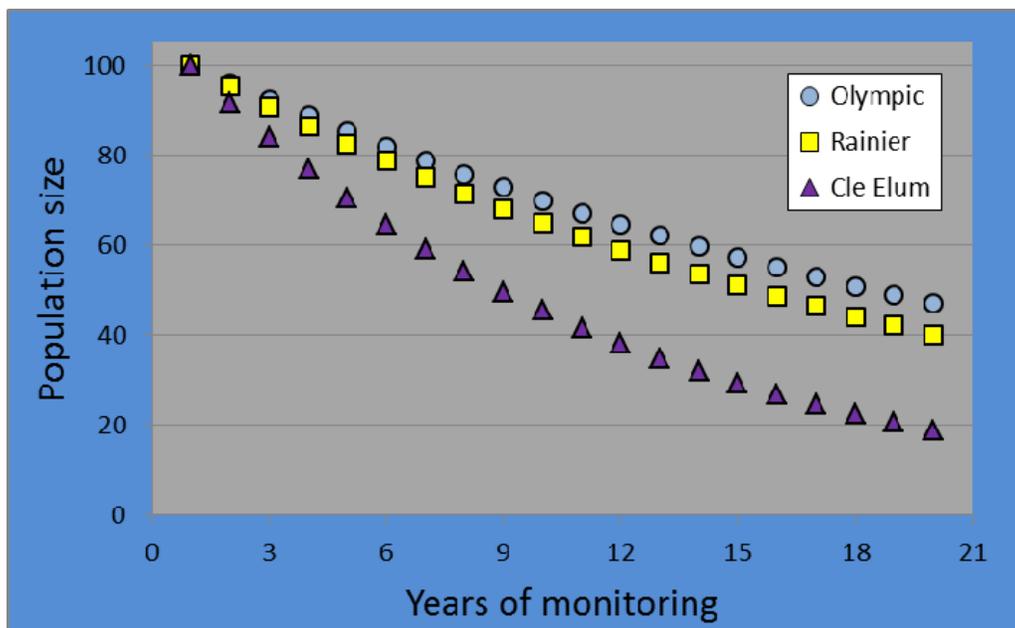


Figure 3. This graph is a general representation of 20-year population declines at three demography study areas in Washington (data from Dugger et al. 2016). These trends represent the cumulative rates (and not the annual rates) based on values found in the right-hand column in Table 2, above.

FACTORS AFFECTING CONTINUED EXISTENCE

Adequacy of regulatory mechanisms. The Northern Spotted Owl was federally listed as threatened in 1990 (U.S. Fish and Wildlife Service 1990). The listing resulted in greater protection of the species' habitat on all lands although it should be noted that harvest of Spotted Owl habitat is allowed under the Northwest Forest Plan, Washington State Forest Practices Rules, and habitat conservation plans. The U.S. Fish and Wildlife Service also designated Critical Habitat which primarily affects management of federal lands and those nonfederal lands for which there exists a federal nexus (e.g. a federal nexus would apply for lands purchased or restored using federal funds) (U.S. Fish and Wildlife Service 2012).

Implementation of the Northwest Forest Plan was meant to provide stable and predictable conservation on federal lands for Spotted Owls and other species associated with late-successional forests (USDA Forest Service and USDI Bureau of Land Management 1994, Noon and Blakesley 2006). Although the Northwest Forest Plan has not been implemented as intended (i.e., much less timber harvest has occurred than was anticipated; Thomas et al. 2006), recent modeling indicates that the lower level of actual timber harvest on federal lands may benefit Spotted Owl recovery (Dunk et al. 2014).

At the state level, forest practices rules for the Spotted Owl were developed when it was federally listed, and after a legal challenge and a subsequent period of interim rules, the current rules were implemented on 1 July 1996. With the exception of minor revisions, those rules have remained unchanged. An evaluation of the forest practices rules was presented to the Forest Practices Board in 2005 (Buchanan and Swedeen 2005). A significant result of this evaluation was a rule change to implement a process to assess the conservation importance of sites that have been surveyed and found to have no Spotted Owl presence for a period of three consecutive years. These sites were formerly regarded as unoccupied and not included in the category of sites (WAC 222-16-010) subject to forest practices critical habitat rules (WAC 222-16-080). Since this new process went into effect there have been no changes in site status which indicates an increase in protection as a result of the process. Forsman et al. (2015) reported that home range composition included 62% selected forest habitat as determined by radio-telemetry (in 1989-1990); this is substantially more than the threshold amount (40% of the area in a 1.8-mile radius circle) which is used under the forest practices rules suggesting the current rules may be insufficient in some landscapes.

Fire risk in dry forests. Large areas of forest in the eastern Cascade Range are now considered to be outside the historical range of variability (Agee 1993, Hessburg and Agee 2003). Specifically, decades of fire suppression, both prior to and subsequent to listing of the Spotted Owl, have altered the tree species composition, structure and spatial distribution of conifer forests with high canopy cover (Hessburg and Agee 2003), and this has continued to intensify and expand the scope of this risk. Some areas that were formerly open dry forest have been invaded by higher densities of trees, often shade tolerant species. As a consequence, fires in such forests may remove substantial areas of forest with high canopy cover and result in landscape conditions that will be unsuitable or less suitable for Spotted Owl use. Fire suppression has created Spotted Owl habitat, but has also created forest conditions, some of

which are not sustainable, such that large fires and impacts of insects and disease may degrade or destroy portions of these forests. The U.S. Fish and Wildlife Service acknowledged the need to address this risk by proactively managing dry forest landscapes (U.S. Fish and Wildlife Service 2011, Henson et al. 2013). There is ongoing debate about the fire ecology of dry forests and the risk of habitat loss due to canopy-replacement fire in the eastern Cascade Range of the Pacific Northwest (Hanson et al. 2009, Spies et al. 2009, DellaSala et al. 2013, Franklin and Johnson 2013).

Competition with Barred Owls. The Barred Owl has expanded its range across the North American continent in the last century and now is found throughout the range of the Spotted Owl in British Columbia, Washington, Oregon and California (U.S. Fish and Wildlife Service 2011). The Barred Owl is closely related to the Spotted Owl, and has a competitive advantage over the Spotted Owl in that it is a habitat and prey generalist (e.g. it can use a broader range of habitat and food types), uses a smaller home range (e.g. is present in higher densities), produces more offspring and has far greater dispersal capability (U.S. Fish and Wildlife Service 2011). Closely-related species generally do not occupy the same habitats and when they do, competition would be expected (Gutiérrez et al. 2007). Barred Owls have become very common in Washington, including in areas that have not recently been occupied by Spotted Owls.

Numerous studies have investigated aspects of the relationship of Spotted Owls and Barred Owls. These investigations have reported habitat relationships (Hamer et al. 2007, Singleton et al. 2010) as well as negative effects of Barred Owls on Spotted Owls relative to pair (or local) extinction rates, colonization rates, or survival (Anthony et al. 2003, Kelly et al. 2003, Olson et al. 2005, Dugger et al. 2011, Kroll et al. 2010, Sovern et al. 2014, Dugger et al. 2016) and hybridization (Kelly and Forsman 2004). Other aspects of competitive interactions that favor Barred Owls over Spotted Owls (Van Lanen et al. 2011, Wiens et al. 2014, Yackulic et al. 2014), including the consequence of factors such as the amount or type of habitat or the level of forest fragmentation (Dugger et al. 2011, Yackulic et al. 2012, Sovern et al. 2014) have also been documented. Barred Owl competition may be the greatest direct factor driving the current and continued population decline of the Spotted Owl and may limit the positive effects of other conservation actions in the near-term.

Climate change. Models of climate change indicate changes in precipitation levels and temperature throughout the Pacific Northwest. Although the models vary in their specific predictions, all of them indicate that substantial changes will occur. As a consequence, it appears likely that such changes will alter conditions in the forest environment. Changes that appear likely include increased temperature, changes in precipitation, less snowpack and increased frequency and intensity of wildfire, and insect and disease outbreaks (Latta et al. 2010, Littell et al. 2010, Chmura et al. 2011). These factors and their resulting consequences have the potential to alter forest conditions in areas used by Spotted Owls. For example, in areas where Douglas-firs are water limited (as in the eastern Cascade Range), further reduction of precipitation may impact the growth and development of this species which is the primary conifer associated with Spotted Owl habitat in much of the Cascade Range. In addition, extensive areas of forest severely damaged by wildfires or insect outbreaks would reduce the area of habitat available for Spotted Owls. Numerous researchers and managers propose using an adaptive management

approach to address forest management in the face of uncertainty associated with climate change effects (Spies et al. 2010, Chmura et al. 2011, Halofsky et al. 2011), and some propose retaining a diverse range of abiotic conditions (e.g. elevation range, aspect, soil type or quality) to maximize the likelihood that appropriate environmental conditions persist to facilitate adaptation of vegetation and wildlife populations (Lawler et al. 2015).

Other factors. Environmental contaminants, hybridization (with Barred Owls), genetic variation, disease, predation, and demographic isolation have been identified as potential threats to Spotted Owls, but none are currently known to impact the population (e.g. Gutiérrez et al. 1995, Kelly and Forsman 2004, Ishak et al. 2008, Funk et al. 2010). The importance of any of these factors could change through time, particularly if the Spotted Owl population continues to decline, because small populations become disproportionately susceptible to factors that may have little if any effect on larger populations (Courchamp et al. 1999).

MANAGEMENT ACTIVITIES

Several key management activities are ongoing within the range of the Spotted Owl. These are briefly described below.

Proposal to designate as endangered status under the Endangered Species Act. The U.S. Fish and Wildlife Service recently indicated it will assess whether the Endangered Species Act status of the Spotted Owl should be changed from threatened to endangered (U.S. Fish and Wildlife Service 2015). That review will also serve as the five-year review for the Spotted Owl.

Demography monitoring. Demographic monitoring is ongoing at three study areas in Washington. These areas have been active for over 20 years (Olympic, started in 1987; Cle Elum, started in 1989; Rainier, started in 1992). A fourth demography study area, the Wenatchee National Forest and vicinity, was active between 1990 and 2003. These ongoing long-term studies provide important information for monitoring trends in demographic vital rates of Spotted Owls. This information is used to assess, adapt, and direct conservation actions to benefit Spotted Owls. Several comprehensive assessments of Spotted Owl demography have come from this work (e.g. Forsman et al. 1996, Franklin et al. 1999, Anthony et al. 2006, Forsman et al. 2011, Dugger et al. 2016).

Barred Owl removal experiment. The revised federal recovery plan outlined the need to implement a Barred Owl removal experiment (U.S. Fish and Wildlife Service 2011). Prior to that, an assessment of various potential methods to manage or assess the competitive interaction between the two owl species concluded that the most effective approach would be to use removal methods (Buchanan et al. 2007). The framework for such an effort was subsequently developed and proposed by Johnson et al. (2008), and aspects of a proposed removal experiment, including its practicality, have been assessed (Diller et al. 2013, U.S. Fish and Wildlife Service 2013), largely based on an initial effort conducted in northern California (Diller et al. 2013). Landscape-level experiments to assess the effects of competitive interactions between Barred Owls and Spotted Owls were implemented in autumn 2015. One of the study areas for the removal experiment is the Cle Elum demography study area in the eastern Cascade Range of

Washington. It is anticipated that four years of data will be collected prior to a formal analysis, although it is likely that preliminary data analyses may be informative (U.S. Fish and Wildlife Service 2013); no project reports have been prepared to date. A single study area project was implemented in northern California, and it is noteworthy that results indicated various positive responses by Spotted Owls when Barred Owls were removed from landscapes in an experimental setting (Dugger et al. 2016).

Dry forest management. Despite disagreement within the scientific community about the need for, and principles of, dry forest management (Hanson et al. 2009, Spies et al. 2009, DellaSala et al. 2013, Franklin and Johnson 2013), implementation of the concept was endorsed by the U.S. Fish and Wildlife Service as a key component of Spotted Owl conservation efforts in forests of the eastern Cascade Range (Henson et al. 2013). Convening a dry forest working group and assessing Spotted Owl responses to fires were identified as necessary actions in the revised recovery plan (U.S. Fish and Wildlife Service 2011). Conceptual and practical aspects of dry forest management have been presented (e.g. Franklin et al. 2008, Hessburg et al. 2015), and have been placed in the context of Spotted Owl conservation (e.g. Irwin et al. 2004, Kennedy and Wimberly 2009, Gaines et al. 2010, U.S. Fish and Wildlife Service 2011).

Incentives program. The Forest Practices Board convened a Northern Spotted Owl Implementation Team (NSOIT) to develop ideas to inform implementation of strategies where incentives could facilitate voluntary measures by landowners to protect Spotted Owl habitat. The discussions by this group were fruitful and the group's work was recognized by the U.S. Fish and Wildlife Service, resulting in a Recovery Action that recommended development of voluntary actions to incentivize conservation (U.S. Fish and Wildlife Service 2008, 2011). A technical team was convened to use modeling to prioritize landscapes where voluntary conservation measures would be most beneficial for Spotted Owls; the group's preliminary report has been released (Dunk et al. 2014) and additional modeling is underway.

Captive breeding in British Columbia. When the population of Spotted Owls in British Columbia had declined to less than 20 known individuals, practical options to restore the population were identified and evaluated by the Spotted Owl Population Enhancement Team. The option that was adopted involved capturing many of the remaining Spotted Owls to establish a captive-bred population whose offspring could subsequently be released to the wild after a period of Barred Owl removal activity (Fenger et al. 2007). The initiative was adopted because the few remaining known owls were largely isolated across the landscape, most of them were not paired, and many were known to be at or near the suspected age of reproductive senescence. This ongoing captive breeding initiative currently includes cooperating facilities in British Columbia, Washington and Oregon. Methods of husbandry are still being refined to enhance captive breeding success. Given the amount and distribution of habitat in British Columbia (Sutherland et al. 2007) it may be possible to restore a population of several hundred Spotted Owls in the province (Chutter et al. 2004). The presence and connectivity of Spotted Owl populations on both sides of the international border should allow for more stability in that part of the owl's range.

CONCLUSION AND RECOMMENDATION

When the Spotted Owl was federally listed in 1990, the primary factor contributing to its status under the Endangered Species Act was the loss of forest habitat. Implementation of the Northwest Forest Plan which guides management of federal forests, and forest practices rules which regulate timber harvest on nonfederal lands, reduced the rate of habitat loss. Habitat loss continues, however, and coupled with a population of Barred Owls that has colonized the range of the Spotted Owl and may still be increasing in abundance, indicates that the declining population of Spotted Owls in Washington has become critically imperiled. Without management that effectively addresses competitive interactions with Barred Owls it is likely the Spotted Owl could become functionally extirpated in Washington in the near-term future. Since its listing in Washington, the endangered status of the Spotted Owl has changed only in that the probability of extirpation has increased. As such, we recommend that the current listing as endangered be retained.

REFERENCES CITED

The references cited in the Periodic *Status Review for the Spotted Owl* are categorized for their level of peer review pursuant to section 34.05.271 RCW, which is the codification of Substitute House Bill 2661 that passed the Washington Legislature in 2014. A key to the review categories under section 34.05.271 RCW is provided in Table A. References were categorized by the author in January 2016.

Individual papers cited cover a number of topics discussed in the report, including information on: 1) the species' description, taxonomy, distribution, and biology; 2) habitat requirements; 3) population status and trends; 4) conservation status and protections; 5) research, monitoring, and restoration activities; and 6) factors affecting the continued existence of the species.

Table A. Key to 34.05.271 RCW categories.

Category Code	34.05.271(1)(c) RCW
i	(i) Independent peer review: review is overseen by an independent third party.
ii	(ii) Internal peer review: review by staff internal to the department of fish and wildlife.
iii	(iii) External peer review: review by persons that are external to and selected by the department of fish and wildlife.
iv	(iv) Open review: documented open public review process that is not limited to invited organizations or individuals.
v	(v) Legal and policy document: documents related to the legal framework for the significant agency action including but not limited to: (A) federal and state statutes; (B) court and hearings board decisions; (C) federal and state administrative rules and regulations; and (D) policy and regulatory documents adopted by local governments.
vi	(vi) Data from primary research, monitoring activities, or other sources, but that has not been incorporated as part of documents reviewed under the processes described in (c)(i), (ii), (iii), and (iv) of this subsection.
vii	(vii) Records of the best professional judgment of department of fish and wildlife employees or other individuals.
viii	(viii) Other: Sources of information that do not fit into one of the categories identified in this subsection (1)(c).

Reference	Category Code
Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press, Washington, DC.	viii
Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, G.C. White, C.J. Schwarz, J.D. Nichols, J.E. Hines, G.S. Olson, S.H. Ackers, L.S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, K.M. Dugger, K.E. Fehring, T.L. Fleming, R.P. Gerhardt, S.A. Gremel, R.J. Gutiérrez, P.J. Happe, D.R. Herter, J.M. Higley, R.B. Horn, L.L. Irwin, P.J. Loschl, J.A. Reid, and S.G. Sovern. 2006. Status and trends in demography of the Northern Spotted Owls, 1985-2003. Wildlife Monographs 163: 1-48.	i
Buchanan, J.B. 2005. Spotted Owl (<i>Strix occidentalis</i>). Pages 217-218 in Wahl, T.R., B. Tweit, and S.G. Mlodinow (editors). Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.	viii
Buchanan, J.B., R.J. Gutiérrez, R.G. Anthony, T. Cullinan, L.V. Diller, E.D. Forsman, and A.B. Franklin. 2007. A synopsis of suggested approaches to address potential competitive interactions between Barred Owls (<i>Strix varia</i>) and Spotted Owls (<i>S. occidentalis</i>). Biological Invasions 9: 679-691.	i
Buchanan, J.B. and P. Swedeen. 2005. Final briefing report to the Washington State Forest Practices Board regarding Spotted Owl status and forest practices rules. Washington Department of Fish and Wildlife, Olympia, Washington.	iv
Carey, A.B. and K.C. Peeler. 1995. Spotted Owls: resource and space use in mosaic landscapes. Journal of Raptor Research 29: 223-239.	i
Chmura, D.J., P.D. Anderson, G.T. Howe, C.A. Harrington, J.E. Halofsky, D.L. Peterson, D.C. Shaw, and J.B. St. Clair. 2011. Forest responses to climate change in the northwestern United States: ecophysiological foundations for adaptive management. Forest Ecology and Management 261: 1121-1142.	i
Chutter, M.J., I. Blackburn, D. Bonin, J. Buchanan, B. Costanzo, D. Cunnington, A. Harestad, T. Hayes, D. Heppner, L. Kiss, J. Surgenor, W. Wall, L. Waterhouse, and L. Williams. 2004. Recovery strategy for the Northern Spotted Owl (<i>Strix occidentalis caurina</i>) in British Columbia. British Columbia Ministry of the Environment, Victoria, British Columbia.	v
Clark, D.A., R.G. Anthony, and L.S. Andrews. 2013. Relationship between wildfire, salvage logging, and occupancy of nesting territories by Northern Spotted Owls. Journal Wildlife Management 77: 672-688.	i
Courchamp, F., T. Clutton-Brock, and B. Grenfell. 1999. Inverse density dependence and the Allee effect. Trends in Ecology and Evolution 14(10): 405-410.	i
Davis, R.J., K.M. Dugger, S. Mohoric, L. Evers, and W.C. Aney. 2011. Northwest Forest Plan—the first 15 years (1994-2008): status and trend of Northern Spotted Owl populations and habitats. General Technical Report PNW-GTR-850. USDA, Forest Service, Pacific Northwest Research Station, Portland, Oregon.	viii
Davis, R.J., B. Hollen, J. Hobson, J.E. Gower, and D. Keenum. In Press. Northwest Forest Plan – the first 20 years (1994-2013): status and trends of Northern Spotted Owl habitats. USDA Forest Service, General Technical Report PNW-GTR XXX. Portland, Oregon.	viii
DellaSala, D.A., R.G. Anthony, M.L. Bond, E.S. Fernandez, C.A. Frissell, C.T. Hanson, and R. Spivak. 2013. Alternative views of a restoration framework for federal forests in the Pacific Northwest. Journal of Forestry 111: 420-429.	i

Diller, L.V., J.P. Dumbacher, R.P. Bosch, R.R. Bown, and R.J. Gutiérrez. 2013. Removing Barred Owls from local areas: techniques and feasibility. <i>Wildlife Society Bulletin</i> 38: 211-216.	i
Dugger, K.M., R.G. Anthony, and L.S. Andrews. 2011. Transient dynamics of invasive competition: Barred Owls, Spotted Owls, habitat, and the demons of competition present. <i>Ecological Applications</i> 21: 2459-2468.	i
Dugger, K.M., E.D. Forsman, A.B. Franklin, R.J. Davis, G.C. White, C.J. Schwarz, K.P. Burnham, J.D. Nichols, J.E. Hines, C.B. Yackulic, P.F. Doherty, Jr., L. Bailey, D.A. Clarke, S.H. Ackers, L.S. Andrews, B. Augustine, B.L. Biswell, J. Blakesley, P.C. Carlson, M.J. Clement, L.V. Diller, E.M. Glenn, A. Green, S.A. Gremel, D.R. Herter, J.M. Higley, J. Hobson, R.B. Horn, K.P. Huyvaert, C. McCafferty, T. McDonald, K. McDonnell, G.S. Olson, J.A. Reid, J. Rockweit, V. Ruiz, S. Saenz, and S.G. Sovern. 2016. The effects of habitat, climate, and Barred Owls on long-term demography of Northern Spotted Owls. <i>Condor</i> 118: 57-116.	i
Dunk, J.R., D.W. LaPlante, K.A. Whittaker, J.B. Buchanan, L. Burnes, K. Halupka, A. Hayes, G. King, T. Melchior, and E. Ryback. 2014. Identifying and evaluating opportunities for conservation of Northern Spotted Owls on nonfederal lands in Washington, U.S.A. Report submitted to Washington Forest Practices Board, Olympia, Washington.	viii
Fenger, M., J.B. Buchanan, T.J. Cade, E.D. Forsman, S.M. Haig, K. Martin, and W.A. Rapley. 2007. Northern Spotted Owl population enhancement and recovery in British Columbia: proposed five-year action plan. Prepared by the Spotted Owl Population Enhancement Team (SOPET) for the government of British Columbia. Victoria, British Columbia, Canada.	v
Forsman, E.D., R.G. Anthony, K.M. Dugger, E.M. Glenn, A.B. Franklin, G.C. White, C.J. Schwarz, K.P. Burnham, D.R. Anderson, J.D. Nichols, J.E. Hines, J.B. Lint, R.J. Davis, S.H. Ackers, L.S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, S.A. Gremel, D.R. Herter, J.M. Higley, R.B. Horn, J.A. Reid, J. Rockweit, J. Schaberl, T.J. Snetsinger, and S.G. Sovern. 2011. Population demography of Northern Spotted Owls. <i>Studies in Avian Biology</i> 40: 1-120.	i
Forsman, E.D., R.G. Anthony, J.A. Reid, P.J. Loschl, S.G. Sovern, M. Taylor, B.L. Biswell, A. Ellingson, E.C. Meslow, G.S. Miller, K.A. Swindle, J.A. Thraillkill, F.F. Wagner, and D.E. Seaman. 2002. Natal and breeding dispersal of Northern Spotted Owls. <i>Wildlife Monographs</i> 149: 1-35.	i
Forsman, E.D., E.M. Glenn, C. Ferland, T. J. Kaminski, J.C. Lewis, K.J. Maurice, and S.G. Sovern. 2005. Home range and habitat use of Northern Spotted Owls on the Olympic Peninsula, Washington. <i>Journal of Raptor Research</i> 39: 365-377.	i
Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the Spotted Owl in Oregon. <i>Wildlife Monographs</i> 87: 1-64.	i
Forsman, E.D., I.A. Otto, S.G. Sovern, M. Taylor, D.W. Hays, H. Allen, S.L. Roberts, and D.E. Seaman. 2001. Spatial and temporal variation in diets of Spotted Owls in Washington. <i>Journal of Raptor Research</i> 35: 141-150.	i
Forsman, E.D., S.G. Sovern, D.E. Seaman, K.J. Maurice, M. Taylor, and J.J. Zisa. 1996. Demography of the Northern Spotted Owl on the Olympic Peninsula and east slope of the Cascade Range, Washington. <i>Studies in Avian Biology</i> 17: 21-30.	i
Forsman, E.D., S.G. Sovern, M. Taylor, and B.L. Biswell. 2015. Home range and habitat selection by Northern Spotted Owls on the eastern slope of the Cascade Mountains, Washington. <i>Journal of Raptor Research</i> 49: 109-128.	i

Franklin, A.B., K.P. Burnham, G.C. White, R.G. Anthony, E.D. Forsman, C. Schwarz, J.D. Nichols, and J.E. Hines. 1999. Range-wide status and trends in Northern Spotted Owl populations. U.S. Geological Survey Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, Colorado.	viii
Franklin, J.F., M.A. Hemstrom, R. Van Pelt, and J.B. Buchanan. 2008. The case for active management of dry forest types in eastern Washington: perpetuating and creating old forest structures and functions. Washington Department of Natural Resources, Olympia, Washington.	viii
Franklin, J.F. and K.N. Johnson. 2013. Ecologically based management: a future for federal forestry in the Pacific Northwest. <i>Journal of Forestry</i> 111: 429-432.	i
Funk, W.C., E.D. Forsman, M. Johnson, T.D. Mullins, and S.M. Haig. 2010. Evidence for recent population bottlenecks in Northern Spotted Owls (<i>Strix occidentalis caurina</i>). <i>Conservation Genetics</i> 11: 1013-1021.	i
Funk, W.C., E.D. Forsman, T.D. Mullins, and S.M. Haig. 2008. Introgression and dispersal among Spotted Owl (<i>Strix occidentalis</i>) subspecies. <i>Evolutionary Applications</i> 1: 161-171.	i
Gaines, W.L., R.J. Harrod, J. Dickinson, A.L. Lyons, and K. Halupka. 2010. Integration of Northern Spotted Owl habitat and fuels treatments in the eastern Cascades, Washington, USA. <i>Forest Ecology and Management</i> 260: 2045-2052.	i
Glenn, E.M., R.G. Anthony, E.D. Forsman, and G.S. Olson. 2011. Reproduction of Northern Spotted Owls: the role of local weather and regional climate. <i>Journal of Wildlife Management</i> 75: 1279-1294.	i
Gutiérrez, R.J. 1996. Biology and distribution of the Northern Spotted Owl. <i>Studies in Avian Biology</i> 17: 2-5.	i
Gutiérrez, R.J., M. Cody, S. Courtney, and A.B. Franklin. 2007. The invasion of Barred Owls and its potential effect on the Spotted Owl: a conservation conundrum. <i>Biological Invasions</i> 9: 181-196.	i
Gutiérrez, R.J., A.B. Franklin, and W.S. LaHaye. 1995. Spotted Owl (<i>Strix occidentalis</i>). <i>The Birds of North America</i> 179: 1-28.	i
Halofsky, J.E., D.L. Peterson, K.A. O'Halloran, and C.H. Hoffman (Editors). 2011. Adapting to climate change at Olympic National Forest and Olympic National Park. USDA Forest Service General Technical Report PNW-GTR 844, Portland, Oregon.	i
Hamer, T.E., E.D. Forsman, and E.M. Glenn. 2007. Home range attributes and habitat selection of Barred Owls and Spotted Owls in an area of sympatry. <i>Condor</i> 109: 750-768.	i
Hanson, C.T., D.C. Odion, D.A. Dellasalla, and W.L. Baker. 2009. Overestimation of fire risk in the Northern Spotted Owl Recovery Plan. <i>Conservation Biology</i> 23: 1314-1319.	i
Hanson, E., D. Hays, L. Hicks, L. Young, and J. Buchanan. 1993. Spotted Owl habitat in Washington. Report to Washington Forest Practices Board, Olympia, Washington.	viii
Henson, P., J. Thraikill, B. Glenn, B. Woodbridge, and B. White. 2013. Using ecological forestry to reconcile Spotted Owl conservation and forest management. <i>Journal of Forestry</i> 111: 433-437.	i
Hessburg, P.F., and J.K. Agee. 2003. An environmental narrative of Inland Northwest United States forests, 1800-2000. <i>Forest Ecology and Management</i> 178: 23-59.	i
Hessburg, P.F., D.J. Churchill, A.J. Larson, R.D. Haugo, C. Miller, T.A. Spies, M.P. North, N.A. Povak, R.T. Belote, P.H. Singleton, W.L. Gaines, R.E. Keane, G.H. Aplet, S.L. Stephens, P. Morgan, P.A. Bisson, B.E. Rieman, R.B. Salter, and G.H. Reeves. 2015. Restoring fire-prone Inland Pacific landscapes: seven core principles. <i>Landscape Ecology</i> DOI 10.1007/s10980-015-0218-0.	i

Ishak, H.D., J.P. Dumbacher, N.L. Anderson, J.J. Keane, G. Valkiūnas, S.M. Haig, L.A. Tell, and R.N.M. Sehgal. 2008. Blood parasites in owls with conservation implications for the Spotted Owl (<i>Strix occidentalis</i>). PLoS One 3: e2304.	i
Irwin, L.L., T.L. Fleming, and J. Beebe. 2004. Are Spotted Owl populations sustainable in fire-prone forests? Journal of Sustainable Forestry 18(4):1-28.	i
Johnson, D.H., G.C. White, A.B. Franklin, L.V. Diller, I. Blackburn, D.J. Pierce, G.S. Olson, J.B. Buchanan, J. Thrailkill, B. Woodbridge, and M. Ostwald. 2008. Study designs for Barred Owl removal experiments to evaluate potential effects on Northern Spotted Owls. Washington Department of Fish and Wildlife, Olympia, Washington.	viii
Kelly, E.G. and E.D. Forsman. 2004. Recent records of hybridization between Barred Owls (<i>Strix varia</i>) and Northern Spotted Owls (<i>Strix occidentalis caurina</i>). Auk 121: 806-810.	i
Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are Barred Owls displacing Spotted Owls? Condor 105: 45-53.	i
Kennedy, R.S.H. and M.C. Wimberly. 2009. Historical fire and vegetation dynamics in dry forests of the interior Pacific Northwest, USA, and relationships to Northern Spotted Owl (<i>Strix occidentalis caurina</i>) habitat conservation. Forest Ecology and Management 258: 554-566.	i
Kroll, A.J., T.L. Fleming, and L.L. Irwin. 2010. Site occupancy dynamics of Northern Spotted Owls in the eastern Cascades, Washington, USA, 1990-2003. Journal Wildlife Management 74: 1264-1274.	i
Latta, G., H. Temesgen, D. Adams, and T. Barrett. 2010. Analysis of potential impacts of climate change on forests of the United States Pacific Northwest. Forest Ecology and Management 259: 720-729.	i
Lawler, J.J., D.D. Ackerly, C.M. Albano, M.G. Anderson, S.Z. Dobrowski, J.L. Gill, N.E. Heller, R.L. Pressey, E.W. Sanderson, and S.B. Weiss. 2015. The theory behind, and the challenges of, conserving nature's stage in a time of rapid change. Conservation Biology 29: 618-629.	i
Littell, J.S., E.E. Oneil, D. McKenzie, J.A. Hicke, J.A. Lutz, R.A. Norheim, and M.M. Elsner. 2010. Forest ecosystems, disturbances, and climatic change in Washington State, USA. Climatic Change 102: 129-158.	i
Noon, B.R. and J.A. Blakesley. 2006. Conservation of the Northern Spotted Owl under the Northwest Forest Plan. Conservation Biology 20: 288-296.	i
Olson, G.S., R.G. Anthony, E.D. Forsman, S.H. Ackers, P.J. Loschl, J.A. Reid, K.M. Dugger, E.M. Glenn, and W.J. Ripple. 2005. Modeling of site occupancy dynamics for Northern Spotted Owls, with emphasis on the effects of Barred Owls. Journal Wildlife Management 69: 918-932.	i
Pierce, D.J., J.B. Buchanan, B.L. Cosentino, and S. Snyder. 2005. An assessment of Spotted Owl habitat on non-federal lands in Washington between 1996 and 2004. Washington Department of Fish and Wildlife, Olympia, Washington.	i
Singleton, P.H., J.F. Lehmkuhl, W.L. Gaines, and S.A. Graham. 2010. Barred Owl space use and habitat selection in the eastern Cascades, Washington. Journal of Wildlife Management 74: 285-294.	i
Sovern, S.G., E.D. Forsman, G.S. Olson, B.L. Biswell, M. Taylor, and R.G. Anthony. 2014. Barred Owls and landscape attributes influence territory occupancy of Northern Spotted Owls. Journal of Wildlife Management 78: 1436-1443.	i
Sovern, S.G., E.D. Forsman, K.M. Dugger, and M. Taylor. 2015. Roosting habitat use and selection by Northern Spotted Owls during natal dispersal. Journal of Wildlife Management 79: 254-262.	i

Spies, T.A., T.W. Giesen, F.J. Swanson, J.F. Franklin, D. Lach, and K.N. Johnson. 2010. Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. <i>Landscape Ecology</i> 25: 1185-1199.	i
Spies, T.A., J.D. Miller, J.B. Buchanan, J.F. Lehmkuhl, J.F. Franklin, S.P. Healey, P.F. Hessburg, H.D. Safford, W.B. Cohen, R.S.H. Kennedy, E.E. Knapp, J.K. Agee, and M. Moeur. 2009. Underestimating risks to the Northern Spotted Owl in fire-prone forests: response to Hanson et al. <i>Conservation Biology</i> 24: 330-333.	i
Sutherland, G.D., D.T. O'Brien, S.A. Fall, F.L. Waterhouse, A.S. Harestad, and J.B. Buchanan. 2007. A framework to support landscape analyses of habitat supply and effects on populations of forest-dwelling species: a case study based on the Northern Spotted Owl. Technical Report 038, British Columbia Ministry of Forests and Range. Victoria, British Columbia.	iv
Thomas, J.W., J.F. Franklin, J. Gordon, and K.N. Johnson. 2006. The Northwest Forest Plan: origins, components, implementation experience, and suggestions for change. <i>Conservation Biology</i> 20: 277-287.	i
USDA Forest Service and USDI Bureau of Land Management. 1994. Record of Decision for amendments to the Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. USDA Forest Service and USDI Bureau of Land Management, Portland, Oregon.	iv
U.S. Fish and Wildlife Service. 1990. Endangered and threatened wildlife and plants: determination of threatened status for the Northern Spotted Owl. <i>Federal Register</i> 55: 26114–26194.	iv, v
U.S. Fish and Wildlife Service. 2008. Final recovery plan for the Northern Spotted Owl (<i>Strix occidentalis caurina</i>). U.S. Fish and Wildlife Service, Portland, Oregon.	iv, v
U.S. Fish and Wildlife Service. 2011. Revised recovery plan for the Northern Spotted Owl (<i>Strix occidentalis caurina</i>). U.S. Fish and Wildlife Service, Portland, Oregon.	iv, v
U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; designation of revised critical habitat for the Northern Spotted Owl; final rule. <i>Federal Register</i> 77: 71876-72068.	iv, v
U.S. Fish and Wildlife Service. 2013. Experimental removal of Barred Owls to benefit threatened Northern Spotted Owls. Final Environmental Impact Statement. U.S. Fish and Wildlife Service, Portland, Oregon.	iv
U.S. Fish and Wildlife Service. 2015. Endangered and threatened wildlife and plants; 90-day findings on 10 petitions. <i>Federal Register</i> 80: 19259-19263.	v
Van Lanen, N.J., A.B. Franklin, K.P. Huyvaert, R.F. Reiser, and P.C. Carlson. 2011. Who hits and hoots at whom? Potential for interference competition between Barred and Northern Spotted Owls. <i>Biological Conservation</i> 144: 2194–2201.	i
Wallin, D.O., F.J. Swanson, B. Marks, J.H. Cissel, and J. Kertis. 1996. Comparison of managed and pre-settlement landscape dynamics in forests of the Pacific Northwest, USA. <i>Forest Ecology and Management</i> 85: 291-309.	i
Washington Department of Fish and Wildlife. In Review. 2015 Washington State Wildlife Action Plan. Washington Department of Fish and Wildlife, Olympia, Washington.	iv
Wiens, J.D., R.G. Anthony, and E.D. Forsman. 2014. Competitive interactions and resource partitioning between Northern Spotted Owls and Barred Owls in western Oregon. <i>Wildlife Monographs</i> 185: 1-50.	i
Wimberly, M.C. 2002. Spatial simulation of historical landscape patterns in coastal forests of the Pacific Northwest. <i>Canadian Journal of Forest Research</i> 32: 1316-1328.	i

Wimberly, M.C., T.A. Spies, C.J. Long, and C. Whitlock. 2000. Simulating historical variability in the amount of old forests in the Oregon Coast Range. <i>Conservation Biology</i> 14: 167-180.	i
Yackulic, C.B., J. Reid, R. Davis, J.E. Hines, J.D. Nichols, and E. Forsman. 2012. Neighborhood and habitat effects on vital rates: expansion of the Barred Owl in the Oregon Coast Ranges. <i>Ecology</i> 93: 1953-1966.	i
Yackulic, C.B., J. Reid, J.D. Nichols, J.E. Hines, R. Davis, and E. Forsman. 2014. The roles of competition and habitat in the dynamics of populations and species distributions. <i>Ecology</i> 95: 265-279.	i

APPENDIX A. WDFW responses to public comments received during the 90-day public review period for the draft *Periodic Status Review for the Northern Spotted Owl in Washington* conducted from 8 September to 8 December 2015. The comments presented here are summaries of the remarks provided by one or more people. We reviewed all public comments and with the exception of comments that resulted in the need to clarify language we made no other substantial changes.

Report Section	Comment and Response
General comments	<p>1. The Northern Spotted Owl should be maintained as an endangered species in Washington (due to reasons such as small population size, declining population, habitat loss, and competitive interactions with Barred Owls).</p>
	<p><i>WDFW is recommending that the status of the Spotted Owl be maintained as state endangered. The trend in Spotted Owl abundance continues a downward trend which demography research indicates is accelerating.</i></p>
	<p>2. The Northern Spotted Owl should not be protected in Washington (because its extinction would be natural, or human needs come first).</p>
	<p><i>Comment noted. By law (WAC 232-12-297), species listing decisions by the state must be based solely on the biological status of the species and its continued existence in the state.</i></p>
	<p>3. The role of the Washington Department of Fish and Wildlife to conserve the Spotted Owl is appreciated.</p>
	<p><i>Thank you for the compliment. Our involvement in Spotted Owl conservation is consistent with the agency mission.</i></p>
	<p>4. Protecting Spotted Owl habitat will protect habitat for other species.</p>
	<p><i>Spotted Owls use mature and older forest conifer forests. Other species that use such habitats will benefit from measures that conserve Spotted Owl habitat.</i></p>
	<p>5. Protecting spotted owls (and habitat) should be valued over short-term economic gain (and to alleviate adverse impacts).</p>
	<p><i>This comment reflects a policy perspective and is therefore beyond the scope of this document. However, we point out that state and federal rules and regulations are designed to address the need to protect Spotted Owl habitat while allowing for lawful resource extraction practices.</i></p>
	<p>6. Keeping the owl listed is needed to withstand market and social pressures that will place human wants over wildlife needs.</p>

Report Section	Comment and Response
	<i>Like any other listed species, the Spotted Owl will be evaluated for listing based on the status of the species and when the threat factors have been satisfactorily addressed the species can be down-listed or de-listed, as appropriate.</i>
	7. Using abiotic means to preserve species will result in less protection in fragmented patches.
	<i>We are unclear about the meaning of this comment. Our reference to abiotic conditions was related to a strategy to maximize adaptation potential to climate change by retaining the greatest diversity of abiotic (e.g. elevation, slope, aspect) conditions on landscapes. We attempted to clarify this language.</i>
	8. An incentive program to facilitate protection of habitat should be supported.
	<i>We agree with this perspective. Providing incentives to landowners to support wildlife is an important tool for recovering listed species. Further discussion of this topic is beyond the scope of this periodic status review, but incentives are discussed as a strategy within the U.S. Fish and Wildlife Service recovery plan for the Northern Spotted Owl. Thank you for the comment.</i>
Factors Affecting Continued Existence	9. Efforts to remove Barred Owls as a means to conserve Spotted Owls will likely be ineffective and a waste of resources.
	<i>The initiative to remove Barred Owls is being implemented using a landscape-level experimental design (which will allow for cause and effect assessment) within four large study areas throughout the range of the Northern Spotted Owl. The WDFW perspective is to formulate an opinion about effectiveness as results of the experiment become available. We are encouraged, however, by results from a separate removal experiment, in northern California, that showed a positive population response by Spotted Owls following removal of Barred Owls.</i>
	10. Efforts to remove Barred Owls should continue and be supported.
	<i>See comment immediately above.</i>
	11. Many species are being impacted by climate change.
	<i>The effects of climate change on Spotted Owls are not clear at this time, but modeling indicates that snow pack will decrease through time and some forest landscapes may experience higher risk of canopy-replacing fires and other impacts. Such events would impact Spotted Owls and other species.</i>
	12. The influence of Barred Owls has been overstated; the problem is habitat loss.

**Report
Section****Comment and Response**

As indicated in the Periodic Status Review, both habitat loss and Barred Owls are significant threats to Spotted Owls. Habitat loss is obviously an important threat factor for Spotted Owls, and excessive harvest can impact individuals and populations. The Barred Owl is a habitat and prey generalist that uses all types and age classes of forest used by Spotted Owls in addition to other classifications of forest not used by Spotted Owls. It is found in wilderness areas and large landscapes with little, if any, recent timber harvest and in landscapes where levels of timber harvest were compatible with continued stability of Spotted Owl populations until the arrival of Barred Owls (e.g. northern California). A landscape-level experiment in northern California has demonstrated that removal of Barred Owls resulted in a strong and positive population response by Spotted Owls (Dugger et al. 2016). While both habitat loss and Barred Owls are important threat factors, if we fail to address the competitive interaction with Barred Owls it seems unlikely that Spotted Owls will persist, let alone recover, based only on a strategy of protecting habitat (U.S. Fish and Wildlife Service 2012).

13. The loss and fragmentation of habitat (old-growth forest) is a big problem.

Habitat is important for Spotted Owls, and excessive harvest can impact individuals and populations. The effect of fragmentation may be relevant, but this factor is not well understood in Washington. Additional information is needed on this subject, because in some other regions the effect of forest edges was documented as benefiting Spotted Owls.

14. Humans have created an environment where Barred Owls can thrive.

We interpret this comment to imply a relationship between forest management practices and the abundance of Barred Owls in the Pacific Northwest. Although this appears to be a commonly-held perspective we are unaware of any supporting information. Barred Owls are habitat and prey generalists that use all types and age classes of forest used by Spotted Owls; we are unaware of information indicating that they preferentially use intensively managed landscapes.

15. Barred Owls may suppress Spotted Owl vocalization rates, and the Spotted Owls may still be present and are not calling.

Published research indicates that Spotted Owl vocalization rates are lower in the presence of Barred Owls and that some Spotted Owls will continue to occupy portions of territories that have been occupied by Barred Owls. Unpublished information generated by the wood products industry indicates that single Spotted Owl pair territories may be overlapped by 5-7 Barred Owl territories. Ongoing demography research indicates that the population decline is real, as detection probability is accounted for in the analyses (Dugger et al. 2016).

16. Flying squirrel populations have also declined.

**Report
Section****Comment and Response**

We are unaware of population assessments indicating a decline in northern flying squirrels. However, a number of published papers indicate that forests with comparatively greater structure (e.g. including snags and large downed wood) support larger populations of certain small mammal prey species of the spotted owl, including flying squirrels.

WASHINGTON STATE STATUS REPORTS, PERIODIC STATUS REVIEWS, RECOVERY PLANS, AND CONSERVATION PLANS

Status Reports

2015 Tufted Puffin
2007 Bald Eagle
2005 Mazama Pocket Gopher,
Streaked Horned Lark, and
Taylor's Checkerspot
2005 Aleutian Canada Goose
2004 Killer Whale
2002 Peregrine Falcon
2000 Common Loon
1999 Northern Leopard Frog
1999 Olympic Mudminnow
1999 Mardon Skipper
1999 Lynx Update
1998 Fisher
1998 Margined Sculpin
1998 Pygmy Whitefish
1998 Sharp-tailed Grouse
1998 Sage-grouse
1997 Aleutian Canada Goose
1997 Gray Whale
1997 Olive Ridley Sea Turtle
1997 Oregon Spotted Frog
1993 Larch Mountain Salamander
1993 Lynx
1993 Marbled Murrelet
1993 Oregon Silverspot Butterfly
1993 Pygmy Rabbit
1993 Steller Sea Lion
1993 Western Gray Squirrel
1993 Western Pond Turtle

Periodic Status Reviews

2015 Brown Pelican
2015 Steller Sea Lion

Recovery Plans

2012 Columbian Sharp-tailed Grouse
2011 Gray Wolf
2011 Pygmy Rabbit: Addendum
2007 Western Gray Squirrel
2006 Fisher
2004 Sea Otter
2004 Greater Sage-Grouse
2003 Pygmy Rabbit: Addendum
2002 Sandhill Crane
2001 Pygmy Rabbit: Addendum
2001 Lynx
1999 Western Pond Turtle
1996 Ferruginous Hawk
1995 Pygmy Rabbit
1995 Upland Sandpiper
1995 Snowy Plover

Conservation Plans

2013 Bats

Status reports and plans are available on the WDFW website at:
<http://wdfw.wa.gov/publications/search.php>

