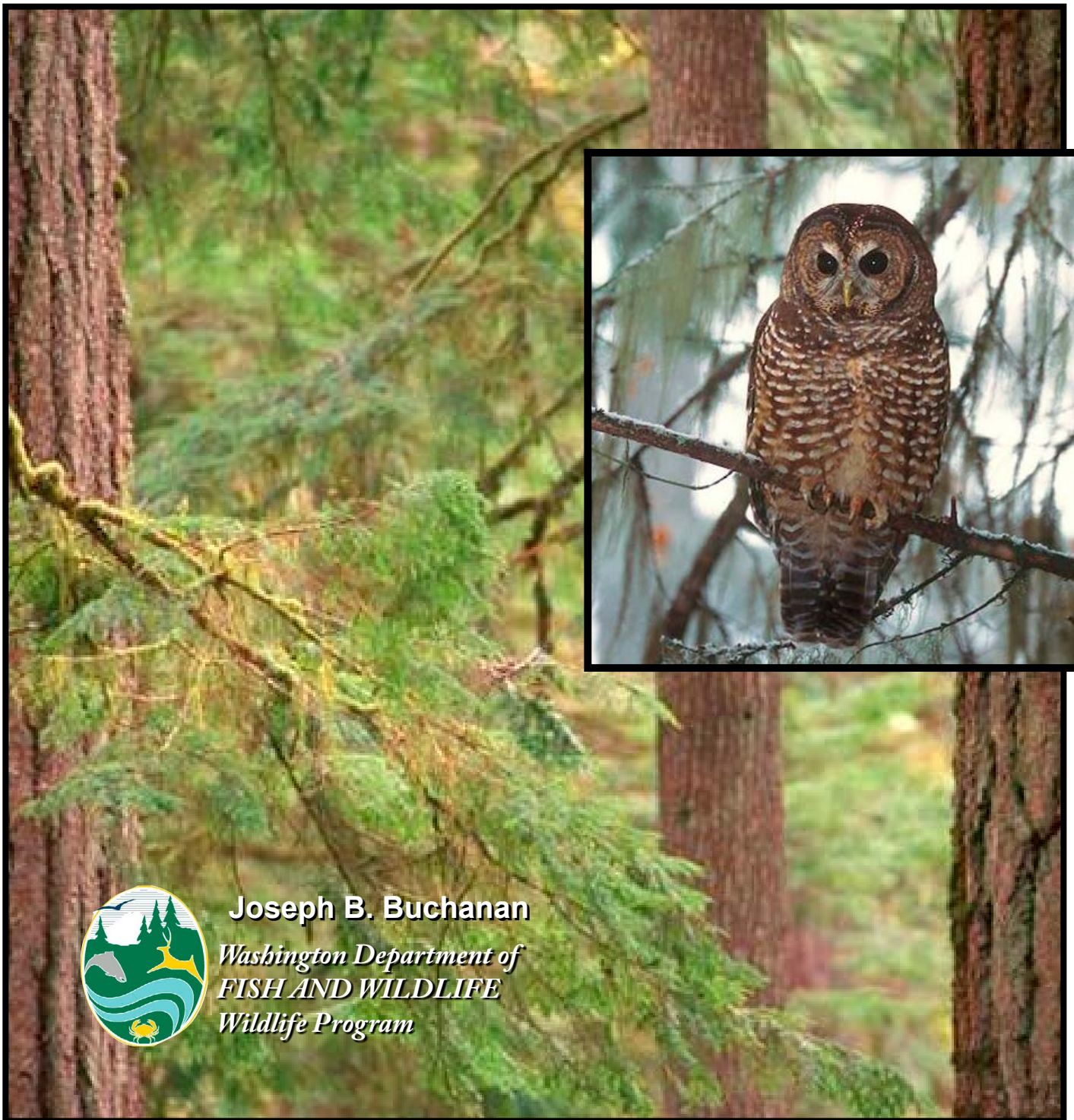


Periodic Status Review for the Northern Spotted Owl



Joseph B. Buchanan

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FISH AND WILDLIFE
Wildlife Program*

The Washington Department of Fish and Wildlife maintains a list of endangered, threatened, and sensitive species (Washington Administrative Codes 220-610-010 and 220-200-100). 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 220-610-110). 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 is the Draft Periodic Status Review for the Northern Spotted Owl. It contains a review of information pertaining to the status of Northern Spotted Owls in Washington. It was reviewed by species experts and is available for a 90-day public comment period from August 1, 2023 through October 29, 2023. Comments received will be considered during the preparation of the final periodic status review. The Department will present the results of this periodic status review to the Fish and Wildlife Commission at a meeting in Winter 2023.

Submit written comments on this document by October 29, 2023 via e-mail to: TandEpubliccom@dfw.wa.gov or by mail to:

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This report should be cited as:

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Cover photos of Northern Spotted Owl and habitat by Jared Hobbins. Inside cover photo courtesy of WDFW.



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Periodic Status Review for the Northern Spotted Owl in Washington



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EXECUTIVE SUMMARY

The Northern Spotted Owl (*Strix occidentalis caurina*; hereafter, Spotted Owl) was listed as an Endangered Species in Washington by the Washington Fish and Wildlife Commission in 1988, and was listed as a Threatened Species under the Endangered Species Act (ESA) 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 northern California. Spotted Owls have very large home ranges (thousands of acres) and use mature and old coniferous forest for nesting, roosting, and foraging; loss of habitat due to timber harvest was the primary reason for its ESA listing. Protections on federal (Northwest Forest Plan) and nonfederal lands (Forest Practices Rules) have reduced the amount of habitat loss due to timber harvest. Population monitoring at three demography study areas in Washington indicate annual rates of change between -5.0 and -9.0% through 2018, continuing an ongoing downward trend for the last three decades.

The closely related Barred Owl (*Strix varia*) expanded its range across North America and arrived in Washington over 55 years ago. The range of the Barred Owl has continued to expand, and it now occurs throughout the range of the Northern Spotted Owl. The Barred Owl has life history traits that enable it to be an effective competitor of the Spotted Owl for resources, and this competitive interaction is now the primary driver of 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 2015, a landscape-scale experiment to remove Barred Owls from Spotted Owl territories at four study areas was implemented; one of the study areas was in the eastern Cascade Range in Washington. Results of the experiment indicated a positive response by Spotted Owls to the removal of Barred Owls. The USFWS is currently working to develop a management strategy to benefit Spotted Owls in the Pacific Northwest and California by managing Barred Owls.

The decline of Spotted Owls has not subsided in Washington and the population has become critically imperiled, having declined by up to 80-90 percent in some predominantly federal landscapes in Washington. The U.S. Fish and Wildlife Service has concluded that uplisting the Spotted Owl from threatened to endangered status under the Endangered Species Act was “warranted but precluded.” We recommend the continued recognition of Endangered status of the species in Washington.

This is an update of the *Periodic Status Review for the Spotted Owl in Washington* that was published in 2016 (Buchanan 2016). This revised Status Review is based largely on the previous document and has been updated to reference new publications regarding demography, competition between Barred Owls and Spotted Owls, and to provide a more contemporary overview of management activities. Language from the previous version was revised to a varying extent to improve conciseness and brevity.

INTRODUCTION

Fifteen species of owls occur in Washington, all except one of which are known or suspected to breed in the state. Eleven species are associated with forests in at least part of their range, and nine 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 subspecies found in the Pacific Northwest (Gutiérrez and others 1995). The Spotted Owl was listed as endangered in Washington by the Fish and Wildlife Commission in 1988, and as federally threatened by the U.S. Fish and Wildlife Service in 1990 (U.S. Fish and Wildlife Service 1990).



Figure 1. Northern Spotted Owl. Photo: WDFW

This periodic status review briefly summarizes the natural history, population status, threats, and recent conservation and management activities involving Spotted Owls in Washington. We assess whether the species should retain its current regulatory status, or if it should be reclassified under state law. We provide a recommendation for the Washington Fish and Wildlife Commission to consider regarding its status.

DISTRIBUTION

The range of the Spotted Owl includes conifer forests of western Washington and the eastern slope of the Cascade Range (Buchanan 2005). In the last four decades, nearly all documented Spotted Owl territories were in the Cascade Range and the Olympic Peninsula (Fig.2). The species no longer occurs in the Puget Lowlands and only 14 Spotted Owl locations have been documented in southwestern Washington (Wildlife and Surveys Data Management, Washington Department of Fish and Wildlife). Spotted Owl site centers (e.g., nest locations) have occurred from near sea level to elevations up to 3,000 feet in the Olympic Mountains and up to about 5,000 feet in parts of the Cascade Range (Buchanan 2005). Within the Cascade Range, the density of Spotted Owls is generally higher in the south and becomes sparse north of Lake Chelan and the Skagit River. Large water bodies appear to be barriers to movement and for this reason the species may not have occurred in the San Juan Islands, where

there are no known records. Due to the ongoing population decline, the occupied portion of the range has almost certainly decreased.

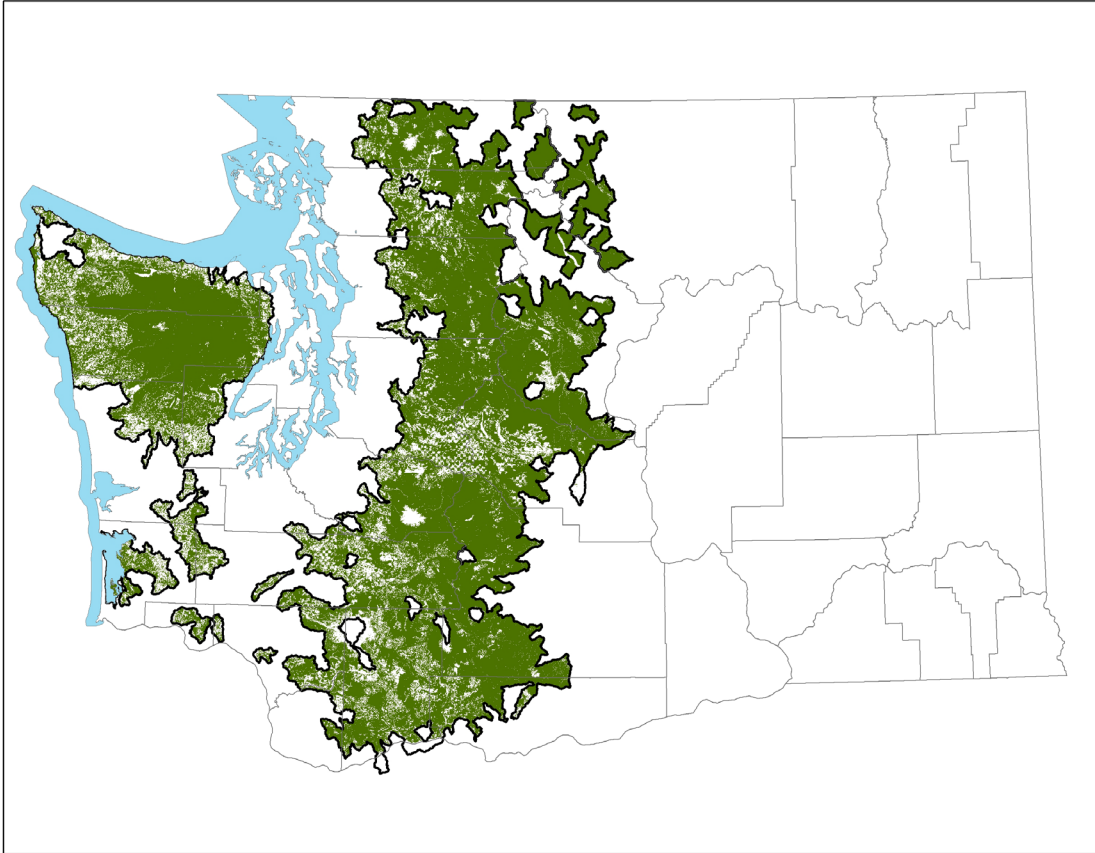


Figure 2. Approximate recent range of the Spotted Owl in Washington, as depicted by the spatial extent of multiple ecological systems (in green; boundaries of specific ecological systems not shown) in HUC-12 watersheds (black outline) that have supported territorial owls at any point in time since the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

NATURAL HISTORY

Habitat. Spotted Owls are birds of the forest. In western Washington, these owls use mature and old-growth forests that contain large-diameter trees, large snags, and a high volume of downed wood. Other habitat features include high canopy cover and multiple size-classes of trees which results in layers of forest canopy. In some areas, hardwoods may be present, but the primary tree species in most habitat in western Washington are Douglas-fir and western hemlock.

Much of the habitat in the eastern Cascade Range is best characterized as forests that are either comparatively young or mature, although some areas are considered old growth. These forests often 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 typically are only a minor component of or are absent from Spotted Owl habitat in eastern Washington (Hanson and others 1993). Habitat conditions used by roosting Spotted Owls during dispersal in the eastern Cascade Range are described by Sovern and others (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 Humboldt's flying squirrel (Forsman and others 2001, Arbogast and others 2017).

Home range and movements. Home range estimates for Spotted Owls in Washington were initially reported by Hanson and others (1993) to facilitate development of forest practices rules. Those data were subsequently analyzed more comprehensively by the principal investigators and are summarized here. Spotted Owls in Washington have home ranges that on average exceed the size of those from other parts of the subspecies' distribution (see summary in Hamer and others 2007). Estimates of home range size (100% minimum convex polygon) were reported for the Olympic Peninsula: mean = 8,916 acres (Forsman and others 2005) and the eastern Cascade Range: mean = 7,124 acres (Forsman and others 2015); a 95% adaptive kernel estimated mean for the northwestern Cascade Range was 6,571 acres (Hamer and others 2007). Home range use varies from one year to the next, likely due to changing prey distributions across the landscape (Carey & Peeler 1995). This variability 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 and others 2005). Spotted Owl home ranges can be characterized as those where the overwintering area is contiguous with the breeding-season area ("winter expansion" of the home range) or where overwintering areas are not nearby and may be several miles from the breeding location ("winter migration") (Hamer and others 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 (i.e., natal dispersal) and, much less frequently, dispersal from a breeding area by adults (i.e., breeding dispersal). Natal dispersal typically begins between late September and early October 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 and others

2002). Recent analyses indicate that natal dispersal distances have decreased (Hollenbeck et al. 2018) and breeding dispersal distances have increased (Jenkins and others 2019), each of these changes related to the negative influence of Barred Owl presence across the landscape.

Reproduction and survival. Ongoing investigations of Spotted Owl demography are summarized and reported in comprehensive updates that are published approximately every four years. This status review includes information collected through 2013 that was presented by Dugger and others (2016) and information collected through 2017 presented by Franklin and others (2021) 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 inside and outside Mount Rainier National Park). The annual rate of population change indicates a negative trend at all three demography study areas in Washington (see Population and Habitat Status, below). From those study areas in Washington, estimates of apparent survival of adults ranged between 0.839 (95% CI = 0.803-0.875; Cle Elum) and 0.877 (95% CI = 0.842-0.896; Rainier) for the period 1993-2018, with a pronounced downward turn after 2011 at Cle Elum and Olympic, and after 2013 at Rainier (Figure 6a in Franklin and others 2021).

Other aspects of Spotted Owl ecology and behavior have been described (Gutiérrez and others 1995). 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 (e.g., Gutiérrez and others 1995). Spotted Owls typically lay two eggs, although sometimes one or three eggs are laid (Gutiérrez and others 1995). For many years, most Spotted Owls across large regions exhibited a pattern of reproducing every-other year (Gutiérrez and others 1995). Additional information on breeding behavior and other components of demography is available (Forsman and others 1984, Gutiérrez and others 1995, Gutiérrez and others 1996, Anthony and others 2006, Glenn and others 2011, Franklin and others 2021). See section immediately below for more details.

POPULATION AND HABITAT STATUS

Global. The Northern 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 and others 2004, Davis and others 2016). In the United States, trends of habitat on all land ownerships in Washington, Oregon and California indicate a net loss of 23.7%, or 2.9 million acres between 1993 and 2017 (Davis and others 2022), approximately 46% of that total representing changes in Oregon, about 30% in California, and 24% in Washington. The estimated amount of Spotted Owl habitat (e.g., 26% of forest in the species' range) is at the low end of the estimated historical range of variability based on landscape assessments conducted in western Oregon, suggesting a substantial area (e.g., between 25-75% of a landscape) of mature and old forest was present prior to European settlement (Wallin and others 1996, Wimberly and others 2000, Wimberly 2002).

The Northern Spotted Owl is experiencing a range-wide population decline. In British Columbia, the population is thought to have declined by 67% between 1992 and 2002 (10.4% per year), and by perhaps 90% since European settlement (Chutter and others 2004). Subsequently, the remaining known owls were removed from the wild to establish a captive breeding program (see Fenger and others 2007). Estimates of population change at demography study areas in the United States indicate declines at all study areas: three in Washington, five in Oregon, and three in northern California (Franklin and others 2021).

Washington. Information on habitat status in Washington is derived from Davis and others (2022), published as part of a series of monitoring reports focused primarily 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 maintaining a sustainable level of timber harvest from federal lands. 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 (Table 1). Changes in the amount of Spotted Owl habitat managed under the Washington State Forest Practices Rules (which directs forest practices on nonfederal lands) between 1996 and 2004 were reported by Pierce and others (2005).

Many low elevation forests – the vast majority located on nonfederal lands – had already been harvested multiple times by the time the Spotted Owl was classified as Endangered by the Fish and Wildlife Commission in 1988. Consequently, most of the unknown number of sites that occurred in lowland areas were lost many years ago, and most known Spotted Owl sites are limited to the Cascade Range and the Olympic Peninsula (Wildlife and Surveys Data Management, Washington Department of Fish and Wildlife). As of July 2019, 945 of 1269 known Spotted Owl sites were classified as Status 1 (pair or reproductive), 21 were Status 2 (two birds, pair status unknown), 111 were Status 3 (territorial single), 161 were Status 4 (single, territorial status unknown), and 31 were Status 5 (historical). These sites, in total, represent all known sites specifically documented to have occurred in Washington. Monitoring data and demography analyses (see below) indicate that many of these sites likely are not currently occupied by Spotted Owls. Additionally, in the last three decades, surveys have been conducted at a small percentage of documented sites (e.g., primarily sites monitored for demography research purposes).

Table 1. Summary of estimated changes in habitat (in acres) on all lands between 1993 and 2017 (data from Davis and others 2022).

Province	1993 habitat estimate	Harvest	Wildfire	Insect	Other	Total explained loss	Percentage loss from 1993
Federal lands							
Olympic Peninsula	719,000	3,600	3,400	300	2,200	6,700	-2.0
Western Lowlands	12,300	1,800	0	0		1,800	-14.4

Western Cascades	1,382,000	14,900	5,800	1,800	10,2500	32,700	-2.4
Eastern Cascades	730,400	31,300	75,200	22,700	7,400	136,700	-18.7
Non-federal lands							
Olympic Peninsula	151,700	74,200	0	500	100	74,700	-49.2
Western Lowlands	222,400	152,800	0	300	0	153,100	-68.8
Western Cascades	407,200	164,500	400	300	0	165,200	-40.6
Eastern Cascades	285,700	122,900	13,900	5,500	100	142,400	-49.8
Totals							
All forest areas	3,911,100	566,000	98,800	31,400	24,400	720,700	-18.4

The annual rate of population change continues to decline significantly at all three demography study areas in Washington (Table 2), where monitoring has occurred for between 26 and 31 years. The rate of change is referred to as lambda (λ) and when $\lambda = 1.0$ a population is considered stable. The values in the right-hand column in Table 2 represent $1.0 - \lambda$ (i.e., $1.0 - 0.916 = 8.4\%$ rate of population change [decline] at Cle Elum). The rate of decline at the Washington study sites ranged between -3.8% and -8.9% as of 2013 (Dugger and others 2016; Table 2), and these values were reported as between -5% and -9% for the three Washington study areas through 2018 (Franklin and others 2021; values were not specified per study area). The declines noted in Washington were greater than those in Oregon or California (Franklin and others 2021).

Table 2. Summary of selected demographic values from three study areas in Washington (from Dugger and others 2016).

Demography Study Areas	Probability of occupancy (in 1995 and 2013)	Mean fecundity of adult females	Apparent survival of adult females	Lambda (λ) value	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%

Franklin and others (2021) recently calculated changes in estimated population size of the Northern Spotted Owl. This calculation covered the years 1995 through 2017, and included neither the years prior to 1995 nor 2018 because “the first two years and the last year of λ estimates were either biased or confounded” (Franklin and others 2021: 11). Between 1995 and 2017 the estimated population size at Rainier had dropped by nearly 75% and the decline at both Cle Elum and Olympic exceeded 80 percent (Franklin and others 2021; and see Glenn and others 2017).

FACTORS AFFECTING CONTINUED EXISTENCE

Competition with Barred Owls. The Barred Owl has expanded its range across North America in the last century and now is found throughout the range of the Northern Spotted Owl in British Columbia,

Washington, Oregon, and California (U.S. Fish and Wildlife Service 2011). The Barred Owl is a habitat and prey generalist (e.g., it can use a broader range of habitats and food types), uses a smaller home range (e.g., it is present in higher densities), produces more offspring, and has far greater dispersal capability compared to the Spotted Owl (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 and others 2007). Barred Owls have become very common in Washington, including in areas that were formerly occupied by Spotted Owls and areas of younger forests that are not used by the latter species.

Numerous studies have investigated aspects of the relationship of Spotted Owls and Barred Owls. These investigations have reported habitat relationships (Hamer and others 2007, Singleton and others 2010) as well as negative effects of Barred Owls on Spotted Owls relative to pair (or local) extinction rates, colonization rates, occupancy, or survival (Anthony and others 2003, Kelly and others 2003, Olson and others 2005, Dugger and others 2011, Kroll and others 2010, Sovern and others 2014, Diller and others 2016, Dugger and others 2016, Mangan and others 2019, Wiens and others 2021) and hybridization (Kelly & Forsman 2004). Other aspects of competitive interactions that favor Barred Owls over Spotted Owls (Van Lanen and others 2011, Wiens and others 2014, Yackulic and others 2014), including the consequence of factors such as the amount or type of habitat or the level of forest fragmentation (Dugger and others 2011, Yackulic and others 2012, Sovern and others 2014, Irwin and others 2020) have also been documented. In addition, Barred Owl occurrence has influenced aspects of natal dispersal distance (Jenkins and others 2019) and the proportion of adults engaging in breeding dispersal (Jenkins and others 2021), both of which indicate negative consequences. Barred Owl competition is 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 (Dunk and others 2019, Franklin and others 2021).

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 & Agee 2003, Hagmann and others 2017). One hundred years of fire suppression have altered tree species composition and the structure and spatial distribution of conifer forests with high canopy cover (Hessburg & Agee 2003). Some areas that were formerly open dry forest have experienced ingrowth of higher densities of trees, often shade tolerant species, resulting in recruitment of closed canopy forest, a substantial amount of which has become Spotted Owl habitat. Consequently, 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 Owls, potentially for many decades, and in some cases resulting in conversion from forest to another cover type (Meigs and others 2022). In short, fire suppression has created Spotted Owl habitat, but has also created forest conditions that are more susceptible to impacts from large fires, insects, and disease that 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 and others 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 and others 2009, Spies and others 2009, DellaSala and others 2013, Franklin

& Johnson 2013, Ganey and others 2017, Jones and others 2018; and see references therein). However, in the last two decades, substantial areas of forest have burned in the eastern Cascade Range, including owl habitat in Late Successional Reserves managed under the Northwest Forest Plan (Davis and others 2022), indicating that habitat loss due to fire has become a major concern in those forests.

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 the protection is not absolute, and that harvest of Spotted Owl habitat is allowed under the Northwest Forest Plan, Washington State Forest Practices Rules, and the numerous Habitat Conservation Plans and Safe Harbor Agreements, which vary in the amount and type of conservation benefit. The U.S. Fish and Wildlife Service 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 & Blakesley 2006). The Northwest Forest Plan has not been implemented as intended in Washington (i.e., less timber harvest has occurred than was anticipated; Thomas and others 2006), and recent modeling indicates that the lower level of actual timber harvest on federal lands may benefit Spotted Owl recovery (Dunk and others 2014, La Plante and others 2017), when implemented in concert with Barred Owl management.

At the state level, forest practices rules for the Spotted Owl were developed when the species was federally listed, and after a legal challenge and a subsequent period of interim rules, the current rules were implemented on 1 July 1996. Other than minor revisions, those rules have remained unchanged. An evaluation of the forest practices rules was presented to the Forest Practices Board in 2005 (Buchanan & Swedeen 2005). A significant result of the evaluation was a subsequent 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. 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).

As mentioned above, regulations and management actions do not eliminate impacts experienced by Spotted Owls. However, it appears that the presence of regulations has reduced the magnitude and extent of timber harvest impacts in specific landscapes involving federal and nonfederal lands.

Climate change. Models of climate change indicate changes in precipitation levels and temperature throughout the Pacific Northwest are anticipated. Although models vary in their specific predictions, all of them indicate that substantial changes will occur. Changes that appear likely include increased

temperature, changes in precipitation, and less snowpack, and these changes may result in increased frequency and intensity of wildfire and insect and disease outbreaks (Latta and others 2010, Littell and others 2010, Chmura and others 2011). These factors and their resulting consequences have the potential to alter forest conditions in areas used by Spotted Owls. For example, reduction of precipitation may impact the growth and development of conifer species 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 (and see J.S. Halofsky and others 2018, Wan and others 2019).

Other factors. Environmental contaminants, hybridization (with Barred Owls), genetic variation, disease, predation, and demographic isolation have been identified as potential threats to Spotted Owls, and some may be impacting the population (e.g., Gutiérrez and others 1995, Kelly & Forsman 2004, Ishak and others 2008, Funk and others 2010, Franklin and others 2018, Gabriel and others 2018, Miller and others 2018, Wiens and others 2019). The importance of any of these factors could change through time, because small populations become disproportionately susceptible to factors that may have little if any effect on larger populations (Courchamp and others 1999). Wan and others (2018) summarized threat factors to all three Spotted Owl subspecies.

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 concluded that uplisting the Spotted Owl from threatened to endangered status was warranted but precluded (U.S. Fish and Wildlife Service 2020). This decision means that although changing the status of the subspecies to endangered was warranted there were other factors (e.g., prioritization of work on other species) that prevented immediate action by the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service indicated that they “will develop a proposed rule to reclassify the Northern Spotted Owl as our priorities allow” (U.S. Fish and Wildlife Service 2020). That decision was subsequently reiterated (U.S. Fish and Wildlife Service 2022).

Demography monitoring. For over three decades, demography studies occurred on three landscapes in Washington: Olympic, which began in 1987; Cle Elum, which began in 1989; and Rainier, which began in 1992. Investigation in a fourth demography study area, the Wenatchee National Forest and vicinity, was conducted between 1990 and 2003. These ongoing long-term studies provided important information for monitoring trends in demographic vital rates of Spotted Owls. This information was 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 and others 1996, Franklin and others 1999, Anthony and others 2006, Forsman and others 2011, Dugger and others 2016). The traditional

demographic work has been discontinued (e.g., Franklin and others 2021) in most areas, including those in Washington, and monitoring efforts have transitioned to use of passive acoustic methods (Duchac and others 2020, Dale and others 2022, Lesmeister and others 2021, 2022, Lesmeister and Jenkins 2022).

Barred Owl management. 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 and others 2007). The framework for such an effort was subsequently developed and proposed by Johnson and others (2008), and aspects of a proposed removal experiment, including its practicality, were assessed (Diller and others 2013, U.S. Fish and Wildlife Service 2013), based in part on an initial effort conducted in northern California (Diller and others 2013). Landscape-level experiments to assess the effects of competitive interactions between Barred Owls and Spotted Owls, one of which included the Cle Elum Demography Study Areas in the eastern Cascade Range of Washington, have been concluded. Results of the experiment indicate positive responses by Spotted Owls to the removal of Barred Owls (Diller and others 2016, Dugger and others 2016, Wiens and others 2021; see Franklin and others 2021, Hofstadter et al. 2022). At present, the U.S. Fish and Wildlife Service is exploring scenarios to implement Barred Owl management within the Pacific Northwest and California; an EIS will be prepared in support of that initiative. WDFW has key involvement in this process.

Dry forest management. Despite disagreement within the scientific community about the need for, and principles of, dry forest management that reduces fire risk (Hanson and others 2009, Spies and others 2009, DellaSala and others 2013, Franklin & Johnson 2013, Jones and others 2018, Prichard and others 2021), implementation of a dry forest management 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 and others 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 and others 2008, Hessburg and others 2015, Hessburg and others 2022), and have been placed in the context of forest management and Spotted Owl conservation (e.g., Irwin and others 2004, Kennedy & Wimberly 2009, Gaines and others 2010, U.S. Fish and Wildlife Service 2011, Jones and others 2020, Davis and others 2022, Gaines and others 2022, WDNR 2022). Forest management practices to restore ecological conditions and reduce fire risk are being implemented on various landownerships in the eastern Cascades, including lands managed by WDFW. The amount of work required is substantial, and outreach regarding approaches to fire risk reduction is essential and will be challenging (Lange and others 2022).

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 that is not currently regulated. 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 initiatives to incentivize conservation (U.S. Fish and Wildlife Service 2008, 2011). See Graves and others (2022) regarding an incentives program in Oregon.

The incentives program includes three components. First, the Department of Natural Resources is seeking legislative authority to implement a programmatic Safe Harbor Agreement for Spotted Owl habitat in which landowners can participate on a voluntary basis or as part of the incentives program. Second, following a hiatus, the NSOIT is being reconvened to continue its work to develop a program to incentivize conservation for nonfederal landowners. An incentives program was developed for Oregon (Graves and others 2022), and initial discussions by the NSOIT indicated a broader spectrum of incentives options might be more conducive to effective engagement at spatial scales meaningful to Spotted Owl conservation. Lastly, a technical team was convened to use modeling to prioritize landscapes where voluntary conservation measures would be most beneficial for Spotted Owls (Dunk and others 2014, La Plante and others 2017). WDFW has been involved in all three aspects of this initiative.

Population augmentation. When the number of Spotted Owls in British Columbia had declined to less than 20 known individuals, practical options to restore the subpopulation were identified and evaluated by the Spotted Owl Population Enhancement Team (Fenger and others 2007). The option adopted by the British Columbia government 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 (see Fenger and others 2007). Barred Owl management has been ongoing in British Columbia (Gillis and Waterhouse 2020). The population augmentation initiative was adopted because the few remaining known owls were largely isolated across the landscape, many 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 (see Environment and Climate Change Canada 2023). Monitoring in demography study areas indicates that Spotted Owl abundance has declined to very low numbers (Franklin and others 2021), and it seems almost certain that effective recovery will require both Barred Owl management and augmentation of the Spotted Owl population, the latter likely involving captive breeding and release, or possibly translocation.

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 habitat. Implementation of the Northwest Forest Plan which guides management of federal forests, and habitat conservation plans and forest practices rules which

regulate timber harvest on nonfederal lands, reduced the rate of habitat loss due to commercial harvest. Despite regulation of impacts to habitat, competition with Barred Owls has critically imperiled the subpopulation of Spotted Owls in Washington, and functional extirpation has likely occurred in some landscapes (e.g., ranger districts, watersheds) or regions (e.g., southwestern Washington) that were occupied by Spotted Owls only two decades ago. Without management that effectively addresses the negative consequences of competitive interactions with Barred Owls it is likely the Spotted Owl could become functionally extirpated in Washington in the near-term future (i.e., in the next decade). 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.

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The references 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.

Table A. Key to 34.05.271 RCW categories.

Category Code	Description of 34.05.271(1)(c) RCW Categories
i	Independent peer review: review is overseen by an independent third party.
ii	Internal peer review: review by staff internal to the department of fish and wildlife.
iii	External peer review: review by persons that are external to and selected by the department of fish and wildlife.
iv	Open review: documented open public review process that is not limited to invited organizations or individuals.
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	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	Records of the best professional judgment of department of fish and wildlife employees or other individuals.
viii	Other: Sources of information that do not fit into one of the categories identified in this subsection (1)(c).

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*Although this document was a WDFW report, it was submitted to an anonymous editor via the Department of Natural Resources, who provided funds for the study, and was subsequently distributed by the editor for peer review by three anonymous subject matter experts.

APPENDIX A.

WDFW responses to public comments. To be added after the 90-day comment period.